FY 2006/2007 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: Feb 2005
Exhibit R-2

BUDGET ACTIVITY: 02
PROGRAM ELEMENT: 0602435N
PROGRAM ELEMENT TITLE: OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH

COST: (Dollars in Thousands)

Project Number & Title	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	56,789	69,601	49,793	50,353	51,620	52,398	53,057	54,058

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 this program are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting Naval material and operations in the BSE. This program 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.

This PE 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 program is related to and fully coordinated with efforts in accordance with the on-going 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). The Navy program includes efforts 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.

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PROGRAM CHANGE SUMMARY:

	FY 2004	FY 2005	FY 2006	FY 2007
FY 2005 President's Budget Submission	62,305	48,482	56,525	55,031
Cong Rescissions/Adjustments/Undist. Reductions	0	-666	0	0
Congressional Action	0	21,800	0	0
Execution Adjustments	-3,946	0	0	0
Non-Pay Inflation Adjustments	-58	0	2	3
Program Adjustments	0	-15	-6,904	-4,954
Rate Adjustments	0	0	170	273
SBIR Assessment	-1,512	0	0	0
FY 2006/2007 President's Budget Submission	56,789	69,601	49,793	50,353

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

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COST: (Dollars in Thousands)

Project Number & Title	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
OCEAN WARFIGHTING ENVIRONMENT APPLIED RESEARCH	56,789	69,601	49,793	50,353	51,620	52,398	53,057	54,058

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project 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 (FNC) programs: Organic Mine Countermeasures (MCM) and Autonomous Operations. This project contains the National Oceanographic Partnership Program (NOPP) (Title II, subtitle E, of Public Law 104-201) and efforts aimed at understanding and predicting the impacts of underwater sound on marine mammals.

Major efforts of this project are devoted to (1) gaining real-time knowledge of the Battlespace Environment (BSE), (2) determining the natural environment needs of regional warfare, (3) providing the on-scene commander with 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 Oceanography Center and to the Naval Oceanographic Office 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. Efforts include ocean and atmospheric analysis and 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 MCM and Anti-Submarine Warfare (ASW) systems. Joint Strike Warfare efforts address issues in air battlespace dominance. Efforts include influences of the natural environment on air operations, electromagnetic (EM)/electro-optic (EO) systems used in intelligence, surveillance, reconnaissance, targeting, bomb damage assessment, and detection of missile weapon systems. They also include improvements in tactical information management about the BSE.

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B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2004	FY 2005	FY 2006	FY 2007
BATTLESPACE ENVIRONMENT (BSE) CONCEPT ENABLERS	16,677	18,869	0	0

This activity focuses on concept enablers for the Battlespace Environment (BSE) which represent technology developments that are expected to provide revolutionary enabling capabilities, but require a long period of development. Consideration is routinely given to the goals of this work 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. 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.

The transition to new activities in this PE resulted in a 100% decrease in FY06 and FY07.

FY 2004 Accomplishments:

- Completed geoclutter effort to elucidate how the sub-sediment seafloor contributes to acoustic clutter and the importance of this environmental effect in anti-submarine warfare. Determined how variability of the sub-sediment seafloor may contribute to false targets and whether a means can be developed to reduce such false targets. (NRL)
- Continued developments, through theory and field measurement, in the air-sea interaction research effort, as a means of improving both ocean and atmospheric forecasts. (NRL)
- Continued marine mammal noise mitigation efforts to develop tools to detect and mitigate effects of noise on marine mammals, especially the noise generated by Naval activities.
- Continued the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; The Partnership for Advancing Interdisciplinary Global Modeling (PARADIGM), a Partnership for Modeling the Marine Environment of Puget Sound, Washington, Global Ocean Data Assimilation Experiment (GODAE), Multi-Disciplinary Ocean Sensors for Environmental Analyses and Networks (MOSEAN), and Hybrid Coordinate Ocean Model (HYCOM).

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- Continued effort to capture uncertainty in environmental predictions as a means of giving the user an idea of the reliability of those predictions. (NRL)
- Continued optimization and miniaturization of accelerometer/gravimeter systems for UUV and submarine gravity based navigation. (NRL)
- Developed techniques for observing system design, targeted observations, and data assimilation for maximum exploitation of novel and conventional observation resources in support of the tactical battlespace environment. (NRL)
- Developed a simulation prototype to analyze novel navigation and communication algorithms for multiple UUVs. (NRL)
- Completed the following NOPP effort: Development and Verification of a Comprehensive Community Model for Physical Processes in the Nearshore Ocean.

FY 2005 Plans:

- Complete development of a new global atmospheric ensemble prediction system for capturing uncertainty in environmental predictions. (NRL)
- Complete the field measurements and analysis of the air-sea interaction research effort, with the goal of improving both ocean and atmospheric forecasts. (NRL)

The following efforts transition to new activity NOPP in FY06:
- Continue marine mammal program on noise mitigation.
- Continue the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones: PARADIGM, GODAE, MOSEAN, and HYCOM.

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY06:
- Continue optimization of algorithms for novel navigation and communications among multiple UUVs. (NRL)
- Continue optimization and miniaturization of accelerometer/gravimeter systems for UUV and submarine gravity based navigation. (NRL)
- Begin work on Advanced Techniques for Net-Centric Warfare to create a Naval Advanced METOC Broker to reliably find and broker data from new and ad-hoc METOC data providers to the warfighter in an automated manner. (NRL)
- Initiate programs in detection of fish by acoustic methods. (NRL)
- Initiate development of a Benthic Unattended (electric) Generator based on oxidation of marine organic sediment matter. (NRL)

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FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

	FY 2004	FY 2005	FY 2006	FY 2007
BATTLESPACE ENVIRONMENT (BSE) SENSORS AND DATA	6,573	7,797	0	0

This activity encompasses efforts to develop new, or enhance existing, shipboard, 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 the 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, MCM, 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.

The transition to new activities in this PE resulted in a 100% decrease in FY06 and FY07.

FY 2004 Accomplishments:

- Provided various measurements of the scattering function to verify that particle type retrieval can be achieved. (NRL)

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- Continued efforts to transition small, low-power, lightweight bioluminescence sensors, which are of importance to Special Operations Forces and the U.S. Naval Oceanographic Office (NAVOCEANO).
- Continued efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continued to perform field data analysis of physics-based models for hyperspectral imaging of the ocean surface/near-surface to establish what information can be deduced about the optical properties of the ocean's upper layers. (NRL)
- Continued development of a shipboard Light detection and Ranging (LIDAR) system for measurement of winds and the near-surface Electromagnetic/Electro-optic (EM/EO) propagation environment. (NRL)
- Continued model development for diver visibility prediction in support of EOD and SPECWAR operations.
- Continued development of sensors to characterize diver visibility in support of EOD and SPECWAR operations.
- Improved physics based algorithms for characterization of seafloor sediments using acoustic returns from Navy tactical sonars and fathometers (continued application of "Through the Sensor" (TTS) techniques). (NRL)
- Continued research into 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. (NRL)
- Used particle composition information to improve estimates of diver visibility and MCM optical system performance. (NRL)
- Transitioned UV airglow-based neutral density contribution to satellite atmospheric drag to NNSOC. (NRL)
- Developed algorithms to fuse through-the-sensor surficial sediment information collected with the AQS-20 mine hunting sonar with historical surface sediment databases. (NRL)
- Continued development of innovative naval biosensors, biomaterials, and bioprocess technology.

FY 2005 Plans:

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY06:
- Continue bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces and NAVOCEANO, 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.
- Continue efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continue to perform field data analysis of physics-based models for hyperspectral imaging of the ocean surface/near-surface to establish what information can be deduced about the optical properties of the ocean's

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upper layers.
- Continue model development for diver visibility prediction in support of EOD and SPECWAR operations.
- Continue development of sensors to characterize diver visibility in support of EOD and SPECWAR operations.
- Identify and model the dominant sources of coastal undersea environmental electric and magnetic noise, and develop methods to mitigate their affects on multiple sensor detection performance. (NRL)
- Conduct a field test of a shipborne LIDAR system for near surface environmental characterization. (NRL)
- Extend studies of ionospheric scintillation phenomena using satellite-satellite measurements providing near global coverage using the CITRIS instrument to STPSAT1 mission. (NRL)
- Continue efforts to develop and test algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Continue development of innovative naval biosensors, biomaterials, and bioprocess technology.
- Initiate programs like SBIR for promising new biological and chemical sensors.
- Participate in joint field work with other AUV technology developers and users to test undersea sensors. (NRL)

The following effort transitions to new activity Physical Oceanography in FY06:
- Continue research into 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 with the ability to impact most Naval Operations and we seek as robust a prediction capability as is possible. (NRL)

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

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	FY 2004	FY 2005	FY 2006	FY 2007
OCEAN AND ATMOSPHERIC MODELING/PREDICTION AND EFFECTS	9,259	10,858	0	0

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 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 into this applied research program. 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.

The transition to new activities in this PE resulted in a 100% decrease in FY06 and FY07.

FY 2004 Accomplishments:

- Completed accurate model simulations of near-bottom solitons generated by tidal flow over bathymetry, and validated the predictions with oceanographic data. (NRL)
- Continued developments in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models. (NRL)
- Continued to employ ocean models to complete 3-D acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems.
- Continued efforts in nested models to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Incorporate high-resolution nests into the NCOM. (NRL)
- Continued development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Pursued further developments in atmospheric effects on electromagnetics and electro-optics.
- Continued development of an end-to-end observation/analysis/prediction system for coastal aerosol and dust.
- Improved the development of an integrated hydrodynamic/acoustic propagation modeling capability by examining the significance of broadband acoustic propagation through overturning bores in phase sensitive signal processing. (NRL)

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- Initiated development of 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.

FY 2005 Plans:

- Complete first tests of coupled global and regional aerosol prediction system with data assimilation. Efforts aim to build on recent successes of the application of atmospheric modeling demonstrated in Operation Enduring Freedom.
- Complete techniques to provide scalable 3-D acoustic propagation model into Navy PE/OAML. (NRL)

The following projects transition to new activity Marine Meteorology in FY06:
- Continue developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to 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.

The following projects transition to new activity Physical Oceanography in FY06:
- Continue development of efforts in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. (NRL)
- Continue to employ ocean models to complete 3-D acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems.
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander.
- Extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range dependence. (NRL)
- Initiate development of predictive capability of internal wave affects on the battlespace, including affects on acoustic transmission.

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FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

	FY 2004	FY 2005	FY 2006	FY 2007
NAVAL WARFARE SYSTEM-FOCUSED EFFORTS	8,205	10,486	0	0

This activity is the only applied research effort 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 activity. The Littoral Zone (LZ) has been the natural environment of greatest interest. Aspects of this environment that greatly impact Naval warfare are the generally shallow waters of the LZ, 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.

The transition to new activities in this PE resulted in a 100% decrease in FY06 and FY07.

FY 2004 Accomplishments:

- Completed analysis of WESTPAC experimental data to quantify acoustic array gain degradation caused by dynamic oceanography. (NRL)
- Demonstrated a correlation-based decision feedback equalizer to improve the reliability of underwater acoustic communications. (NRL)
- Continued development in remote sensing techniques, which include passive/active optical electromagnetic acoustic techniques and derived products. (NRL)

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- Continued developments in the area of underwater acoustics and the impact of ocean dynamics on underwater acoustics because of their general importance to acoustic systems. (NRL)
- Continued developments in environmentally sensitive, physics-based decision tools and measures of effectiveness in assessment and predictive systems as a means for providing the fleet useful environmental tactical decision aids for antisubmarine warfare as well as strike and mine warfare. (NRL)
- Continued to measure/model ship wake acoustics for anti-torpedo torpedo acoustic performance prediction. (NRL)
- Continued improvements in shock physics and numerics for an explosive mine neutralization model. (NRL)
- Continued to develop ability to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Performed measurements of acoustic transmission across a surface ship wake. (NRL)
- Continued developments in the area of utilization of acoustic processing techniques to perform acoustic or geoacoustic inversion for environmental parameters, developed techniques for discrimination between environmental scatterers and target, and through-the-sensor measurements and adaptation of sensors to the environment. (NRL)
- Pursued techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in prediction of mine burial. (NRL)
- Continued techniques for analysis and exploitation of through-the-sensor technology for rapid environmental assessment in support of Sea Strike. (NRL)
- Continued development of techniques for improving high-resolution environmental fields required for chemical/biological warfare. (NRL)
- Developed a model to predict inorganic and organic particle concentrations from a remote sensing image for ASW and MIW optical system applications. (NRL)
- Developed an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to understand the effects of internal gravity waves on acoustic propagation and array performance. (NRL)

FY 2005 Plans:

- Initiate and complete geoacoustic inversion techniques by verifying predictions of rough surface scattering theories with laboratory measurements. (NRL)
- Initiate and complete explosive placement pattern for air-dropped MCM weapon systems using improved sediment shock physics models. (NRL)

The following efforts transition to new activity Coastal Geosciences/Optics/Biology in FY06:

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- Continue development in remote sensing techniques, especially the hyperspectral and motion imagery techniques in the LZ which offer new possibilities for exploitation based on previous investigation. (NRL)
- Continue development of techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in naval Warfare. (NRL)
- Initiate development of adaptive algorithms to improve MCM electro-optic sensor performance. (NRL)
- Initiate development of an underwater geo-magnetic noise model. (NRL)

The following efforts transition to new activity Ocean Acoustics in FY06:
- Continue to develop ability to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Continue analysis of experimental data sets to quantify the impact of dynamic oceanography on acoustic ASW system performance. (NRL)
- Continue development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. (NRL)

The following efforts transition to new activity Marine Meteorology in FY06:
- Continue development of techniques for analysis and exploitation of through-the-sensor technology for rapid environmental assessment in support of Sea Strike. (NRL)
- Continue further development of techniques for improving high-resolution environmental fields required for chemical/biological warfare. (NRL)

The following effort transitions to new activity Physical Oceanography in FY06:
- Continue developments environmentally sensitive, physics-based decision tools, and measures of effectiveness in predictive systems. (NRL)

FY 2006 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

FY 2007 Plans:

- Program transitions to new activities as noted in FY 2005 plans.

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	FY 2004	FY 2005	FY 2006	FY 2007
Marine Meteorology	0	0	9,509	9,645

The marine atmosphere affects most aspects of Naval operations. This activity develops observing technologies, models, numerical weather prediction (NWP) systems and tactical decision aids (TDA) that describe the atmospheric environment and its impacts on naval sensors and operations. This activity focuses on uniquely marine aspects of atmospheric science such as air-sea interaction, coupled ocean-atmosphere modeling, electromagnetic (EM) and electro-optic (EO) propagation, coastal meteorology, tropical cyclone prediction and the use of remote sensing to obtain quantitative observations of atmospheric properties. Aspects of the atmospheric environment of particular interest include near-surface phenomena that affect refractivity, marine boundary layer dynamics that affect clouds, rain, visibility and fog, and processes that control tropical cyclone structure, track, and intensity. Objectives of this activity are improved NWP systems and TDAs that provide nowcast and forecast skill at global, regional, and tactical scales for operational support, sensor and system development, and performance prediction.

The transition from other activities in this PE resulted in a 100% increase in FY06 and FY07.

FY 2004 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2005 Plans:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enabler, Ocean and Atmospheric Modeling/Prediction and Effects, and Naval Warfare System-Focused Efforts.
- Continue development of techniques for analysis and exploitation of through-the-sensor technology for rapid environmental assessment in support of Sea Strike. (NRL)
- Continue developments in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to many modern warfare systems.

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- Complete development of a technique for improving high-resolution environmental fields required for chemical/biological warfare defense. (NRL)
- Complete development of 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.
- Initiate exploitation of optimal methods for capturing uncertainty of environmental predictions on regional and local scales for reliability estimates of tactical parameters. (NRL)

FY 2007 Plans:

Continue all efforts of FY 2006 less those noted as completed.

	FY 2004	FY 2005	FY 2006	FY 2007
Physical Oceanography	0	0	13,217	13,409

The goal of this activity is to develop Naval tactical uses of knowledge of the physics of the ocean within the battlespace environment. This is achieved through the development of predictive models of the water mass structure, waves, currents, and air-sea interactions and developing measurement/observation technology. Other applications utilize knowledge of the interaction of the water column hydrodynamics and the acoustics to predict the undersea transmission characteristics and sources of uncertainty in these statistics. Utilizing knowledge of the ocean surface physics, the physical oceanography program seeks to exploit the combination of remotely sensed data, in-situ data, and adaptively sampled data to optimize predictions of ocean currents and water column structure. These predictions, custom databases, adaptive sampling schemes and data programs serve ASW, NSW, Sea-Basing, and mine warfare needs.

The transition from other activities in this PE resulted in a 100% increase in FY06 and FY07.

FY 2004 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2005 Plans:

- Funded in other activities noted in the FY 2006 plans.

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FY 2006 Plans:

Efforts noted below transitioned from BSE Sensors and Data, Ocean and Atmospheric Modeling/Predictions and Effects, and Naval Warfare System-Focused Efforts.
- Continue to employ ocean models to complete 3-D acoustic simulations of space-time coherence of the acoustic field, which is a primary characteristic related to detection performance of acoustic systems.
- Continue development of predictive capability of internal wave affects on the battlespace, including affects on acoustic transmission.
- Continue to develop improved 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 with the ability to impact most Naval Operations and we seek as robust a prediction capability as is possible. (NRL)
- Continue developments in atmospheric and ocean model nowcast/forecast systems at a variety of scales (global, regional, semi-enclosed seas, local) including relocateable and nested models dependent on other priorities in this area. (NRL)
- 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 nests into the NCOM. (NRL)
- Continue development in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander. (NRL)
- Continue developing environmentally sensitive, physics-based decision tools, and measures of effectiveness in predictive systems. (NRL)
- Continue to extend current theory dealing with tidal variations in sound-speed to sound-speed events with strong range dependence. (NRL)

FY 2007 Plans:

- Continue all efforts of FY 2006 less those noted as completed.
- Initiate development of planning tools for riverine systems, and begin development of very high resolution, riverine models for SPECOPS. (NRL)

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	FY 2004	FY 2005	FY 2006	FY 2007
Coastal Geosciences/Optics/Biology	0	0	11,735	11,883

The goal of this activity is to determine the sources, distribution, and natural variability (concentration and properties) of optically important matter in the coastal ocean in support of Naval Mine, Undersea, and Special Warfare. Research investments by this activity support the development and testing of expendable and autonomous bioluminescence sensors, the continued development of extended range underwater imaging technologies, and algorithm development and testing for application to ocean color remote sensing from aircraft and space in order to characterize key features of the coastal battle space such as bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties.

The transition from other activities in this PE resulted in a 100% increase in FY06 and FY07.

FY 2004 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2005 Plans:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enablers, BSE Sensors and Data, and Naval Warfare System-Focused Efforts.
- Continue to pursue techniques to allow determination of sediment microfabric and geotechnical properties and their exploitation in prediction of mine burial. (NRL)
- Continue bioluminescence sensor effort with emphasis on needs of the Special Warfare (SPECWAR) forces and NAVOCEANO, 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.
- Continue efforts to use space-based optical sensors as input for both active and passive optical MCM sensor performance prediction models.
- Continue programs like SBIR for promising new biological and chemical sensors.

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- Continue model development for diver visibility prediction in support of EOD and SPECWAR operations.
- Continue development of sensors to characterize diver visibility in support of EOD and SPECWAR operations.
- Continue studies of ionospheric scintillation phenomena on communications and navigation systems with inclusion and analysis of data from CITRIS and development of improved techniques for nowcasting/forecasting ionospheric disturbances. (NRL)
- Continue to refine algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Continue development of innovative naval biosensors, biomaterials, and bioprocess technology.
- Continue development of gravity-based navigation by deploying a conventional gravimeter on a submarine. (NRL)
- Continue work on Advanced Techniques for Net-Centric Warfare to create a Naval Advanced METOC Broker to reliably find and broker data from new and ad-hoc METOC data providers to the warfighter in an automated manner. (NRL)
- Continue programs in detection of fish by acoustic methods.
- Continue to identify and model the dominant sources of coastal undersea environmental electric and magnetic noise and develop methods to mitigate their affects on multiple sensor detection performance. (NRL)
- Complete analysis of physics-based models for hyperspectral imaging of the ocean surface/near-surface to establish what information can be deduced about the optical properties of the ocean’s upper layers.
- Complete algorithm developments for novel navigation and communications among multiple UUVs. (NRL)
- Complete a technique using hyperspectral and motion imagery in the LZ which offer new possibilities for exploitation based on previous investigation. (NRL)
- Complete field test of a shipborne LIDAR system for near surface environmental characterization. (NRL)
- Complete development of a Benthic Unattended Generator to power an autonomous ocean environmental profiler and provide demonstration. (NRL)
- Initiate development of optical property retrieval techniques to generate sharper images from optical sensors that are often blurred by the environment. (NRL)

FY 2007 Plans:

Continue all efforts of FY 2006 less those noted as completed.
- Complete development of adaptive algorithms for image enhancement using an operation MCM electro-optic system and provide a demonstration. (NRL)
- Complete development of a Benthic Unattended Generator to power an autonomous underwater acoustic sensor node and provide a demonstration. (NRL)

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- Complete development, testing, and transition of algorithms that fuse sediment information extracted from operational sonars with historical sediment databases. (NRL)
- Complete development of gravity-based navigation and a prototype accelerometer/gravimeter system. (NRL)
- Complete development and testing of an underwater geo-magnetic noise model. (NRL)
- Complete work on Advanced Techniques for Net-Centric Warfare to create a Naval Advanced METOC Broker to reliably find and broker data from new and ad-hoc METOC data providers to the warfighter in an automated manner. (NRL)
- Initiate transition of advanced techniques for nowcasting/forecasting ionospheric disturbances to operational entities. (NRL)
- Initiate investigation of optical data assimilation methods that make use of AUV based sensors for diver visibility prediction in support of EOD and SPECWAR operations. (NRL)
- Initiate exploration of mounting hyperspectral sensors on man-carried UAVs for riverine and terrestrial target detection for SPECOPS.
- Initiate research into use of additional sensors to expand upon capability to use hyperspectral and motion imagery techniques in the LZ which offer new possibilities for exploitation based on previous investigation. (NRL)
- Expand observations and investigations of ionospheric phenomena on communications and navigation systems with development of global UV remote sensing capability of the ionosphere from geo-synchronous orbit. (NRL)

	FY 2004	FY 2005	FY 2006	FY 2007
Ocean Acoustics	0	0	5,418	5,518

This activity is dedicated to the determination of the impact of the natural ocean environment on acoustic wave phenomena in support of Naval undersea warfare and underwater force protection operations. This activity studies underwater acoustic propagation, scattering from ocean boundaries, and ambient noise issues that impact the development and employment of acoustic systems. The Littoral Zone (LZ) has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic systems, are the shallow water included in the LZ, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to rapid changes of the ocean structure. The objectives of this program are met through measuring, analyzing, modeling and simulating, and exploiting ocean acoustic factors to gain advantage over potential adversaries using undersea acoustic systems. Results of this activity support acoustic sensor and system development, performance prediction, and tactical decision aids.

The transition from other activities in this PE resulted in a 100% increase in FY06 and FY07.

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FY 2004 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2005 Plans:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from Naval Warfare System-Focused Efforts.
- Continue to develop a method to optimize 3-D sonar search path by incorporating environmental uncertainty into the acoustic propagation estimates. (NRL)
- Continue development of an integrated hydrodynamic/acoustic propagation modeling capability for littoral regions to predict acoustic ASW system performance in dynamic environments. (NRL)
- Complete analysis of experimental data sets to quantify the impact of dynamic oceanography on acoustic ASW system performance. (NRL)

FY 2007 Plans:

Continue all efforts of FY 2006 less those noted as completed.
- Complete and transition an initial integrated hydrodynamic/acoustic propagation modeling capability for littoral regions. (NRL)

	FY 2004	FY 2005	FY 2006	FY 2007
National Oceanographic Partnership Program (NOPP)	0	0	9,914	9,898

This activity focuses on U.S. Navy investments in the National Oceanographic Partnership Program (NOPP). NOPP, established by the U.S. Congress (Public Law 104-201) in Fiscal Year 1997, is a unique collaboration among 15 federal agencies involved in conducting, funding, or utilizing results of ocean research. NOPP's value to the Navy derives from the capacity of the partnership to enable and ensure multi-agency efforts where such collaboration enhances efficiency or effectiveness, and/or reduces costs. Major areas of investment by NOPP include: (1) development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to effect it; (2) modernization of

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ocean research and observation infrastructure; and, (3) marine mammal-related research.
The transition from other activities in the PE resulted in a 100% increase in FY06 and FY07.

FY 2004 Accomplishments:

- Funded in other activities noted in the FY 2006 plans.

FY 2005 Plans:

- Funded in other activities noted in the FY 2006 plans.

FY 2006 Plans:

Efforts noted below transitioned from BSE Concept Enabler.
- Continue marine mammal program on noise mitigation.
- Continue the following NOPP efforts begun in earlier years: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; PARADIGM, GODAE, and HYCOM.
- Complete the following NOPP effort: MOSEAN.

FY 2007 Plans:

- Continue all efforts of FY 2006 less those noted as completed.

CONGRESSIONAL PLUS-UPS:

	FY 2004	FY 2005
BIOLUMINESCENCE TRUTH DATA MANAGEMENT AND SIGNATURE DETECTION	961	990

FY04: This effort funded research into the development of affordable, compact, efficient sensors that allow ease of deployment and permit the rapid measurement of bioluminescence in the world’s oceans in order to create a database for future research.

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FY05: Continue research into the development of affordable, compact, efficient sensors that allow ease of deployment and permit the rapid measurement of bioluminescence in the world's oceans in order to create a database for future research. 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.

	FY 2004	FY 2005
CARBON NANOTUBE-BASED RADIATION HARD NON-VIOLATILE RAM	0	4,457

Effort supports Carbon Nanotube-Based Radiation Hard Non-Violatile RAM.

	FY 2004	FY 2005
CENTER FOR MARITIME SYSTEMS	2,691	0

The Center for Maritime Systems (CMS) focused on two key areas in the emerging needs for the design of small vessels capable of operating in coastal regions in a wide range of weather and ocean conditions: establishing an environment where engineering disciplines associated with hull design and ship automation can be brought together, and utilizing this unique education and research environment to identify new areas for research and invent new tools to meet the Navy's needs.

	FY 2004	FY 2005
COASTAL ENVIRONMENTAL EFFECTS	0	4,160

Effort supports Coastal Environmental Effects.

	FY 2004	FY 2005
EXTENDED CAPABILITY UNDERWATER OPTIC IMAGING	2,165	990

FY04: This effort funded the research into development of smaller, more energy efficient sensors for autonomous underwater vehicles with an enhanced ability to detect and identify man-made objects in support of mine and undersea warfare.

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FY05: This effort continues research into development of smaller, more energy efficient sensors for autonomous underwater vehicles with an enhanced ability to detect and identify man-made objects in support of mine and undersea warfare.

	FY 2004	FY 2005
INTEGRATED LITTORAL SENSOR NETWORK	0	990

The central goal of the Integrated Littoral Sensor Network is to integrate scientific resources and understanding so as to enable rapid and effective response to potential terrorist threats as well as to episodic natural or accidental hazards, such as severe storms, harmful algae blooms or toxic spills. Deliverables to the Navy will be a portable suite of sensors, models and informatics techniques for detection, diagnosis, and predictions of manmade and natural water-borne pathogens and toxins in ports, bays and littoral waters.

	FY 2004	FY 2005
OCEANOGRAPHIC SENSORS FOR MCM/AUTONOMOUS MARINE SENSORS	4,493	2,476

FY04: This effort funded research into the development of small, low-power sensors to use on small autonomous underwater vehicles designed for covert characterization of denied areas, thereby giving the Navy a new capability in MCM operations.

FY05: Continue research into the development of small, low-power sensors to use on small autonomous underwater vehicles designed for covert characterization of denied areas, thereby giving the Navy a new capability in MCM operations.

	FY 2004	FY 2005
SOUTH-EAST ATLANTIC COASTAL OCEAN OBSERVING SYSTEM (SEACOOS)	5,765	4,953

FY04: This effort provided funding for SEACOOS which is a regional partnership that integrates the coastal ocean observing system for a four-state region of southeast coastal U.S. (NC, SC, GA, FL). This effort has importance for Homeland Security as well as for Naval oceanography in general.

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FY05: This effort continues funding for SEACOOS. It enhances data access to significantly improve the understanding of atmospheric, oceanic and coupled behaviors in the southeastern U.S., Bahamas, northern Caribbean basin and in the surrounding larger-scale systems.

	FY 2004	FY 2005
SURA COASTAL OCEAN OBSERVATION PROGRAM (SCOOP)	0	2,575

The Southeastern Universities Research Association (SURA) Coastal Ocean Observing Prediction (SCOOP) Program works towards the goal of providing a national system for observing and predicting the myriad events that occur in America's vital coastal waters. The SCOOP proposes to take on the task of integrating diverse systems at the national level. Deliverables are software modules for data transport and data translation, computing storage & services, numerous demonstrations, and program integration.

C. OTHER PROGRAM FUNDING SUMMARY:
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:
PE 0602601F (Space Technology)
PE 0602784A (Military Engineering Technology)
PE 0603401F (Advanced Spacecraft Technology)

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D. ACQUISITION STRATEGY:
Not applicable.