Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602435N *I Ocean Wrfghtg Env Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	79.941	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	Continuing	Continuing
0000: *Ocean Wrfghtg Env Applied Res*	0.000	42.222	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	Continuing	Continuing
9999: *Congressional Adds*	0.000	37.719	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.719

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

This PE provides the unique, fundamental programmatic instrument by which basic research on the natural environment is transformed into technological 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 technological 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 BSE 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy	Date: February 2018
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602435N *I Ocean Wrfghtg Env Applied Res*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	42.618	42.411	45.132	-	45.132
Current President's Budget	79.941	42.411	42.998	-	42.998
Total Adjustments	37.323	0.000	-2.134	-	-2.134
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.073	0.000			
• SBIR/STTR Transfer	-1.751	0.000			
• Program Adjustments	0.000	0.000	-1.426	-	-1.426
• Rate/Misc Adjustments	0.001	0.000	-0.708	-	-0.708
• Congressional Add Adjustments	39.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 9999: *Congressional Adds*		
Congressional Add: *AGOR Mid-life Refit*	29.014	0.000
Congressional Add: *Naval Special Warfare Maritime Science and Technology*	4.836	0.000
Congressional Add: *Space-Based Monitoring in the Artic Basin*	3.869	0.000
Congressional Add Subtotals for Project: 9999	37.719	0.000
Congressional Add Totals for all Projects	37.719	0.000

Change Summary Explanation

The FY 2019 funding request was reduced by $0.150 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602435N / *Ocean Wrfghtg Env Applied Res*	Project (Number/Name) 0000 / *Ocean Wrfghtg Env Applied Res*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Ocean Wrfghtg Env Applied Res*	0.000	42.222	42.411	42.998	-	42.998	43.104	43.227	44.083	44.978	Continuing	Continuing

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. Furthermore, this technical base provides developments that may be utilized in the Future Naval Capabilities 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: gaining real-time knowledge of the Battlespace Environment (BSE), determining the natural environment needs of regional warfare, providing the on-scene commander with the capability to exploit the environment to tactical advantage and, 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, and continuing support to research vessels of the U.S. Academic Research Fleet for operations, maintenance, repair and upgrades that enable applied research at sea and provides modeling and analysis for environmental compliance for ONR/NRL field work and active acoustic experiments. 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, 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: Coastal Geosciences/Optics	6.604	7.904	8.019	0.000	8.019
Description: The goal of the Coastal Geosciences/Optics activity is to understand and predict the nearshore and coastal battlespace environment and its evolution. Studies address coupled phenomena affecting the hydrodynamical, geological, geophysical, and optical properties of the littorals through development of theory, predictive models and field measurement campaigns. Research results support safe and efficacious Naval Mine, Undersea, and Special Warfare operations.					
FY 2018 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Conduct research investments in 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. Complete the effort to demonstrate an extremely compact hyperspectral imager (HSI) employed to retrieve coastal environmental products, ultimately from very small unmanned aerial vehicles (UAVs), by modifying a prototype sensor, incorporating smartphone technology for control and processing and evaluate the performance for quantitative retrieval of environmental products. Complete the effort to couple sediment models that use accurate numerical representations of coastal sediment dynamics with coastal optical modeling systems in order to accurately forecast the appearance and persistence of near-bottom turbidity layers and sediment re-suspension events. Undersea Warfare Applied research focused on minimizing the logistics burden of persistently maintaining multiple sensors in remote or challenged locations. The research emphasizes technologies leading to non-platform-based systems through novel power sources and power-harvesting. For example, benthic microbial fuel cells (BMFCs) are prototype power supplies that generate power from the oxidation of sedimentary organic matter and are intended for marine deployed sensor systems presently powered by batteries. BMFCs can provide power for long-term, uninterrupted operation of Anti-Submarine Warfare; Intelligence, Surveillance and Reconnaissance; and scientific systems otherwise limited in operational lifetime by battery depletion. Battlespace Environments Continue to conceptualize and perform laboratory, field, and numerical modeling studies to understand and exploit various geoscience and optical environmental phenomena in areas that are scientifically challenging, require innovation, and are of interest to the Navy/Marine Corps. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments designed to understand geological/geophysical, biological, and optical phenomena in the oceans and littoral zones, and to validate that understanding. Continuing developing new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and though-the-sensor techniques to obtain, store, utilize, merge and/or exploit data and create operationally and tactically useful environmental information of the littorals and bottom.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Continue specification and development of sensors, signal processing, inversion, and other analysis tools when needed. ***FY 2019 Base Plans:*** Research investments in this activity support the development and testing of models, sensors, algorithm development and testing to enable prediction of coastal battlespace environments anywhere on the globe. Efforts include ocean color remote sensing to characterize bathymetry, shallow-water bottom types, and the distribution of ocean water optical properties in the littorals and the demonstration of a compact hyperspectral imager to retrieve coastal environmental products from small UAVS. Additional efforts develop shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and though-the-sensor techniques to create operationally and tactically useful environmental descriptions of the littorals and sea bottom. Battlespace Environments: Continue to conceptualize and perform laboratory, field, and numerical modeling studies to understand and exploit various geoscience and optical environmental phenomena in areas that are scientifically challenging, require innovation, and are of interest to the Navy/Marine Corps. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments designed to understand geological/geophysical, biological, and optical phenomena in the oceans and littoral zones, and to validate that understanding. Continue applied research to develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and though-the-sensor techniques to obtain, store, utilize, merge and/or exploit data and create operationally and tactically useful environmental information of the littorals and bottom. Continue specification and development of sensors, signal processing, inversion, and other analysis tools when needed. Undersea Warfare: Conceptualize and perform laboratory and field studies to understand and exploit energy storage and retrieval from the benthic interface and the potential to balance small scale and large scale intermittent power generation with power demand for persistent operation of marine sensors presently powered by batteries. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: Marine Mammals and Biology	3.519	3.407	3.630	0.000	3.630

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Description: The Marine Mammals and Biology activity focus is to better understand and characterize the effects of underwater sounds produced by Navy sources (especially sonar) on marine mammals. Efforts include research on integrated ecosystems, effects of sound exposure on marine mammals, and improving the monitoring and detection of marine mammals. The research in this program supports Navy environmental compliance information needs and facilitates acquiring LOAs from NOAA that enable all Navy training and testing operations, and the development of appropriate state-of-the-art mitigation measure. ***FY 2018 Plans:*** Integrated Ecosystem Research: Conduct research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Initiate a multidisciplinary approach using tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields. Effects of Sound: Conduct research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. Initiate research to characterize the causal chain of events leading from sound exposure to "biologically significant" behavioral reactions that might increase risks of population-level effects and/or the potential for stranding. Conduct research to develop an understanding of the natural variation of stress markers, better understand and characterize the relationships among hormones or other biomarkers in different matrices and characterize the relationship between the physiological stress response in marine mammals and acoustic exposure. Monitoring and Detection: Conduct research to develop and test new and existing technology to detect and classify marine mammals in the marine environment and during periods of low light. Continue the development and testing of new autonomous hardware platforms using passive acoustics and/or IR to detect and classify marine mammals. ***FY 2019 Base Plans:*** Integrated Ecosystem Research: Continue research to understand the patterns and causes of variability in the distribution and abundance of marine mammals over space and time. Continue multidisciplinary approach using tagging, visual surveys, and passive acoustics to collect baseline measures of marine mammal behaviors and distributions relative to environmental features and marine mammal prey fields.					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Effects of Sound: Continue research on behavioral, physiological (hearing and stress response), and potentially population-level consequences of sound exposure on marine life. Continue research to characterize the causal chain of events leading from sound exposure to "biologically significant" behavioral reactions that might increase risks of population-level effects and/or the potential for stranding. Continue research to develop an understanding of the natural variation of stress markers, better understand and characterize the relationships among hormones or other biomarkers in different matrices and characterize the relationship between the physiological stress response in marine mammals and acoustic exposure. Monitoring and Detection: Continue research to develop and test new and existing technology to detect and classify marine mammals in the marine environment and during periods of low light. Continue the development and testing of new autonomous hardware platforms using passive acoustics and/or IR to detect and classify marine mammals. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: Marine Meteorology	10.338	9.419	9.567	0.000	9.567
Description: The Marine Meteorology 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, Electric Magnetic (EM) and Electric Optical (EO) propagation, coastal meteorology, Tropical Cyclone (TC) 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 TC 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. ***FY 2018 Plans:*** Perform field measurements; theoretical analyses; development of data fusion, data assimilation and modeling technologies; increasing knowledge content of data from remote sensing and through-the-sensor systems;					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
exploring dynamical and physical processes, coupled atmosphere/ocean/wave/ice/land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments and telescoping, global-to-tactical scale numerical simulations specifically designed to understand atmospheric environmental processes and phenomena. Includes efforts to develop appropriate inversion and other techniques to obtain atmospheric environmental data from airborne and spaceborne sensors. Includes empirical and numerical model development techniques and associated efforts designed to improve atmospheric prediction, diagnose problems and increase the efficiency and accuracy of those models and model systems in a variety of computational environments. Includes efforts to fuse, merge and exploit atmospheric data and create operationally useful information. The research is coordinated with operational customers to enable rapid transition of research into operations. Initiate the development of a version of the Navy's regional NWP prediction system (COAMPS - Coupled Ocean/ Atmosphere Mesoscale Prediction System) that incorporates new physics and is optimized to provide much more accurate forecasts in the Arctic, particularly for poorly predicted phenomena like polar lows, and couples with ocean and ice forecast models. Complete the effort to utilize satellite microwave radiometers to introduce a reliable sea spray source term and demonstrate the new source term within the Navy Aerosol Analysis and Prediction System (NAAPS) for the purposes of global aerosol modeling to produce reliable forecasts of EO propagation, weather, and climate, as a result of the ability to accurately model maritime aerosols. Complete the effort to develop a unique, flexible, situation-dependent, operational meteorology and oceanography (METOC) nowcast support capability to improve nowcast skill based on dynamic ship-following, high-resolution, rapidly updated data assimilation and mesoscale modeling called CSI (COAMPS-OS Ship-following Infosphere). ***FY 2019 Base Plans:*** Perform field measurements; theoretical analyses; development of data fusion, data assimilation and modeling technologies; increasing knowledge content of data from remote sensing and through-the-sensor systems; exploring dynamical and physical processes, coupled atmosphere/ocean/wave/ice/land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. Studies encompass the design, performance, analysis and underlying theory of field and laboratory experiments and telescoping, global-to-tactical scale numerical simulations specifically designed to understand atmospheric environmental processes and phenomena. These studies include efforts to develop appropriate inversion and other techniques to obtain atmospheric environmental data from airborne and spaceborne sensors. Research is coordinated with operational customers to enable rapid transition of research into operations. Initiate the					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
development of a version of the Navy's regional NWP prediction system (COAMPS) that incorporates new physics and is optimized to provide much more accurate forecasts in the Arctic, particularly for poorly predicted phenomena like polar lows, and couples with ocean and ice forecast models. Battlespace Environments: Perform field measurements; theoretical analyses; development of data fusion, data assimilation and modeling technologies; increasing knowledge content of data from remote sensing and through-the-sensor systems; exploring dynamical and physical processes, coupled atmosphere/ocean/wave/ice/ land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. Encompasses the design, performance, analysis and underlying theory of field and laboratory experiments and telescoping, global-to-tactical scale numerical simulations specifically designed to understand atmospheric environmental processes and phenomena. Includes efforts to develop appropriate inversion and other techniques to obtain atmospheric environmental data from airborne and spaceborne sensors. Includes empirical and numerical model development techniques and associated efforts designed to improve atmospheric prediction, diagnose problems and increase the efficiency and accuracy of those models and model systems in a variety of computational environments. Includes efforts to fuse, merge and exploit atmospheric data and create operationally useful information. The research is coordinated with operational customers to enable rapid transition of research into operations. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: National Oceanographic Partnership Program (NOPP) ***Description:*** This activity focuses on US Navy investments in the National Oceanographic Partnership Program (NOPP). NOPP, established by the US 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. NOPP topics address scientific problems that cross-agency missions, fall in gaps between agencies and/or are too large for any one agency to fund itself. ***FY 2018 Plans:***	8.626	8.611	8.781	0.000	8.781

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to affect it, modernization of ocean research and observation infrastructure, and marine mammal-related research. Specific research activities include conducting studies to develop an integrated coastal ocean observation system and associated sensors, communications, data acquisition, storage and processing tools. Efforts will also be initiated to develop small space-based sensors for littoral oceanographic and atmospheric dynamics research; tools for improved production and application of high resolution sea surface temperature data; and miniaturized, next generation sensors for ocean measurements. ***FY 2019 Base Plans:*** Further development of an integrated coastal ocean observation system and development of sensors, communications and data acquisition, storage and processing tools required to affect it, modernization of ocean research and observation infrastructure, and marine mammal-related research. Continue applied research activities to include conducting studies to develop an integrated coastal ocean observation system and associated sensors, communications, data acquisition, storage and processing tools. Continue efforts to develop small space-based sensors for littoral oceanographic and atmospheric dynamics research; tools for improved production and application of high resolution sea surface temperature data; and miniaturized, next generation sensors for ocean measurements. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019					
Title: Ocean Acoustics ***Description:*** The Ocean Acoustics 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 has been the ocean environment of greatest interest. Aspects of this environment, that greatly impact underwater acoustic systems, are the shallow water, 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	2.288	2.060	2.074	0.000	2.074

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
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. ***FY 2018 Plans:*** Undersea Warfare applied research to provide the Warfighter with improved Anti-Submarine Warfare (ASW) performance assessment models and tactical decision aids to plan ASW operations, evaluate effectiveness of ASW systems, and enable environmental adaptive system control. The capability to provide ASW sensor and system performance models, realistic simulations, and measures of effectiveness that incorporate and exploit critical environmental knowledge requires coupling ocean dynamics and acoustics, ambient noise characterization in the littorals, acoustic and optical scattering and propagation characterization, through-the-sensor measurement techniques for in situ environmental parameters, measurement and prediction of uncertainty, and development of tactical decision tools. Efforts include continuation of applied research to enhance passive sonar performance capability in the Arctic environment by developing a better passive sonar performance prediction model and new acoustic ice-characterization methods. ***FY 2019 Base Plans:*** Continue applied research to provide the Warfighter with improved Anti-Submarine Warfare (ASW) performance assessment models and tactical decision aids to plan ASW operations, evaluate effectiveness of ASW systems, and enable environmental adaptive system control. Continue to provide ASW sensor and system performance models, realistic simulations, and measures of effectiveness that incorporate and exploit critical environmental knowledge requires coupling ocean dynamics and acoustics, ambient noise characterization in the littorals, acoustic and optical scattering and propagation characterization, through-the-sensor measurement techniques for in situ environmental parameters, measurement and prediction of uncertainty, and development of tactical decision tools. Continue efforts of applied research to enhance passive sonar performance capability in the Arctic environment by developing a better passive sonar performance prediction model and new acoustic ice-characterization methods. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
There is no significant change from FY 2018 to FY 2019.					
Title: Physical Oceanography	10.847	11.010	10.927	0.000	10.927
Description: The goal of the Physical Oceanography activity is to develop knowledge of the physics of the ocean within the battlespace environment to enable tactical naval use and exploitation of the battlespace. 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 Anti-Submarine Warfare, Naval Special Warfare, and Mine and Expeditionary Warfare. ***FY 2018 Plans:*** Conduct applied research including field research on ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore and riverine environments is directed towards model system development and analysis. Model and data assimilation development is extending to the field of coupled models including air-ice-wave-ocean-land models. This encompasses the design, analysis and underlying theory of field and laboratory experiments designed to understand ocean environmental processes and phenomena. It includes model development to improve ocean environmental predictive capabilities, through improved physical characterization, diagnosis, efficiency and accuracy of these models in a variety of computational environments. Also includes efforts to develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and "through the sensor" techniques to obtain physical oceanographic environmental data. Includes effort to fuse and exploit oceanographic data to create operationally useful information. Conduct applied research that develops and tests the Remote Ocean Sampling System for the air-sea surface flux sampling, while also developing an advanced autonomy for operations of gliders plus unmanned underwater vehicles (UUVs)in extreme environments and develop ocean drifters with stable salinity sensors and high resolution turbulence sensors. Completion of the effort to develop a capability to estimate global ocean forecast uncertainty from ensembles which will enable risk assessment with skill out to 30 days, providing the real-time assessment of environmental uncertainty anywhere on demand and risk analysis products that can be used					

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total

as inputs to existing decision support tools such as risk quantification and mission planning. Completion of the effort to develop a new capability for accurate and rapid characterization of the local ocean battlespace utilizing the ability of gliders to work in coordinated teams and 4-dimensional variational assimilation (4D-Var) to maximize impact of the glider data in a high resolution local forecast model for more accurate ocean predictions around Sea Base and Sea Strike areas.

The research is coordinated with operational customers to enable its rapid transition into operational systems.

FY 2019 Base Plans:

Conduct applied oceanographic research including field campaigns to study ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore environments. Data assimilation development extends use of coupled modeling approaches to include air-ice-wave-ocean-land models. Studies develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and "through the sensor" techniques to obtain physical oceanographic environmental data, and to fuse and exploit oceanographic data to create operationally useful information. Efforts continue to develop and test the Remote Ocean Sampling System for air-sea surface flux sampling as well as developing advanced autonomy for operations of gliders in extreme environments. Additional efforts develop ocean drifters with stable salinity sensors and high resolution turbulence sensors. Completion of the effort to develop a capability to estimate global ocean forecast uncertainty from ensembles which will enable risk assessment with skill out to 30 days, providing the real-time assessment of environmental uncertainty anywhere on demand and risk analysis products that can be used as inputs to existing decision support tools such as risk quantification and mission planning. Completion of the effort to develop a new capability for accurate and rapid characterization of the local ocean battlespace utilizing the ability of gliders to work in coordinated teams and 4-dimensional variational assimilation to maximize impact of the glider data in a high-resolution local forecast model for more accurate ocean predictions.

Battlespace Environments: A program including field research on ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore and riverine environments is directed towards model system development and analysis. Model and data assimilation development is extending to the field of coupled models including air-ice-wave-ocean-land models. Encompasses the design, analysis and underlying theory of field and laboratory experiments designed to understand ocean environmental processes and phenomena. It includes model development to improve ocean environmental predictive capabilities, through improved physical characterization, diagnosis, efficiency and accuracy of these models in a variety

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 0000 / *Ocean Wrfghtg Env Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
of computational environments. Also includes efforts to develop new or enhance existing shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion and "through the sensor" techniques to obtain physical oceanographic environmental data. Includes effort to fuse and exploit oceanographic data to create operationally useful information. The research is coordinated with operational customers to enable its rapid transition into operational systems. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	42.222	42.411	42.998	0.000	42.998

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

All Science and Technology model improvements undergo a rigorous validation verification and evaluation against quantifiable metrics before being accepted for transition into operations. In Marine Meteorology, for example, typical improvements over the past decade have amounted to a gain in skill of one forecast-day (i.e., the 4-day forecast is now as skillful as the 3-day forecast of a decade ago), and tropical cyclone forecast track error has been reduced by 50%. It is expected that future increases in skill will continue at or above this pace.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy											Date: February 2018	
Appropriation/Budget Activity 1319 / 2					R-1 Program Element (Number/Name) PE 0602435N / *Ocean Wrfghtg Env Applied Res*				Project (Number/Name) 9999 / *Congressional Adds*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	0.000	37.719	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.719

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: AGOR Mid-life Refit ***FY 2017 Accomplishments:*** AGOR 23 Class research vessel mid-life refit completed the major overhaul and service life extension of the third ship in the class, the AGOR 25 ATLANTIS. The overhaul replaced obsolete ship propulsion systems, enabled compliance with environmental regulations, increased efficiency and mission performance, and add up to fifteen years to the service life of the vessel. ***FY 2018 Plans:*** N/A	29.014	0.000
Congressional Add: Naval Special Warfare Maritime Science and Technology ***FY 2017 Accomplishments:*** Funds supported applied oceanographic research to exploit ocean currents, water surface and seafloor roughness, and ocean optoacoustical properties, among other phenomena, to enhance underwater vehicle and diver operations. ***FY 2018 Plans:*** N/A	4.836	0.000
Congressional Add: Space-Based Monitoring in the Artic Basin ***FY 2017 Accomplishments:*** Conducted remote sensing studies of ocean phenomena and related ocean/ atmosphere/ice/land interactions in the Arctic and northern latitudes. ***FY 2018 Plans:*** N/A	3.869	0.000
Congressional Adds Subtotals	37.719	0.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy		Date: February 2018
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 9999 / *Congressional Adds*

E. Performance Metrics

Congressional Interest Items not included in other Projects.