Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Navy	Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	0.000	77.935	103.586	74.622	-	74.622	75.626	77.139	78.682	80.255	Continuing	Continuing
0000: *Ocean Wrfghtg Env Applied Res*	0.000	59.593	70.086	74.622	-	74.622	75.626	77.139	78.682	80.255	Continuing	Continuing
9999: *Congressional Adds*	0.000	18.342	33.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.842

A. Mission Description and Budget Item Justification

Assuring access to the global maritime domain is ensured by technologies that reliably and accurately sense and predict the ocean environment. Coordinated distributed maritime operations is only possible when timely, actionable information is delivered to commanders. This program element (PE) addresses applied research to develop and exploit tactical understanding of the ocean environment to maintain U.S. maritime superiority and ensure national security. Research performed in this PE transforms basic oceanographic, geologic, acoustic, optical and chemical research into predictive models and technologies that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). The objectives of this program are met through direct observation of the ocean environment by shipboard, unmanned vehicle, drifting, profiling and remote sensing modalities, among others; assimilation of these observations into predictive environmental models; and provision of critical environmental knowledge to tactical decision aids.

Today's Sailors and Marines are enabled by naval Science and Technology (S&T). Since 1946, the Office of Naval Research (ONR) has fostered scientific research related to the maintenance of maritime superiority and national defense. ONR manages the Department of the Navy's (DON) portfolio of naval Basic and Applied research, and Advanced Technology Development investments to ensure naval forces can effectively deter conflict, but when called upon, fight, win and come home safe. Current investments hedge against uncertainty, providing solutions to commanders today, and options for the future. The Naval S&T budget supports higher guidance defined by the National Defense Strategy, and responds to requirements identified by the Secretary of the Navy through research priorities set by the Chief of Naval Research, coordinated across the Naval Research Enterprise (NRE), and outlined in the Naval R&D Framework.

This Program Element (PE) funds Applied Research, which is the systematic study to understand the means to meet a recognized and specific need. Most of the work in this PE can be classified between Technology Readiness Level (TRL) 2 (technology concept and/or application formulation) and TRL 4 (component and/or breadboard validation in laboratory environments).

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B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	79.881	70.086	0.000	-	0.000
Current President's Budget	77.935	103.586	74.622	-	74.622
Total Adjustments	-1.946	33.500	74.622	-	74.622
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	33.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.077	0.000			
• SBIR/STTR Transfer	-1.869	0.000			
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Adjustments to Budget Year	-	-	74.622	-	74.622

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2021	FY 2022
Project: 9999: *Congressional Adds*		
Congressional Add: *Task Force Ocean*	9.654	10.000
Congressional Add: *Navy Special Warfare Superiority in Underseas and Maritime Environments*	4.827	0.000
Congressional Add: *Ocean Acoustics for Monitoring*	3.861	0.000
Congressional Add: *Climate change hydraulic modeling risk analysis*	0.000	1.500
Congressional Add: *Continuous distributed sensing systems*	0.000	5.000
Congressional Add: *Research vessel cyber infrastructure improvements*	0.000	4.000
Congressional Add: *Ocean acoustics*	0.000	8.000
Congressional Add: *Operational demonstration of commercially available, long endurance USV*	0.000	5.000
Congressional Add Subtotals for Project: 9999	18.342	33.500
Congressional Add Totals for all Projects	18.342	33.500

Change Summary Explanation

Schedule: No significant change.

Technical: No significant change.

Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Navy	Date: April 2022
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Funding: No significant change.

FY 2023 funding increase reflects the fact that the FY 2022 President's Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
0000: *Ocean Wrfghtg Env Applied Res*	0.000	59.593	70.086	74.622	-	74.622	75.626	77.139	78.682	80.255	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project provides the foundational environmental knowledge for undersea, surface and air-based warfighting technologies and effective operations anywhere on the globe, as well as the operation of unattended sensors and unmanned air, surface and underwater vehicles. This project includes the National Oceanographic Partnership Program (NOPP) 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), understanding the variability between processes in the world's ocean, providing the on-scene commander with the capability to exploit the environment to tactical advantage. Research results are 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. Efforts include ocean and atmospheric analysis and prediction for real-time description of the operational environment from space to sub-seafloor, shallow water acoustics, sensors for undersea surveillance and weapon systems, and influences of the natural environment on Mine Countermeasures, Naval Mining, Anti-Submarine Warfare (ASW) and Naval Special Warfare systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Title: Coastal Geosciences/Optics	9.889	10.535	9.417	0.000	9.417
Description: The Coastal Geosciences/Optics activity develops knowledge of the littoral, nearshore and riverine environments in which physical, acoustical and optical processes are dominated by the presence of the sea or river bed and air-water interface. Predictive environmental models, custom climatological databases, adaptive sampling schemes, technologies for nearshore observations and advanced remote sensing capabilities provide critical foundational information for Naval Special Warfare, Mine and Expeditionary Warfare and Amphibious operations. This Program emphasizes field research in navally relevant environments, including many that require research outside the U.S. ***FY 2022 Plans:*** -GuST turbulence probe: Conclude development of the GuST turbulence probe. -Satellite Based Sensing: Continue improving the world's global bathymetry map from satellite data. Specific new efforts will utilize ICESAT for shoreline digital elevation models and connect with new investigations and methods extending altimetry-based seabed models up onto the continental shelves. Continue efforts focused on determining bathymetry from satellite based-remote sensing for shallow muddy and turbid waters.					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
-Inner Shelf Processes: Continue studies of non-hydrostatic modeling of inner shelf processes, including internal waves and fronts. Initiate a systematic study of biases introduced into the inner shelf sea-surface-temperature field by the global ocean and atmospheric models. -Remote Sensors: Continue optimization studies of adaptive sampling in the littorals using a small unmanned aerial vehicle that is also capable of underwater maneuver. -Optics: Initiate studies of underwater image prediction. -Sonar: Continue technology development to observe and map bottom currents and bathymetry from drifting, bottom- following sensors. - Continue research into exploiting various geoscience and optical environmental phenomena in the littoral ocean we will investigate and develop a novel remote sensing technology by exploring advanced machine learning methods for multi-spectral (optical and passive microwave) satellite observations to provide a high-resolution, holistic land surface analysis of surface vegetation and soil parameters and quantify their impact on numerical weather prediction (NWP) models. Continue to build capabilities to predict topographic changes in sandy, coastal environments impacting traffic					
FY 2023 Base Plans: - Continue Satellite Based Sensing to improve the world's global bathymetry map from satellite data. Specific new efforts will utilize ICESAT for shoreline digital elevation models and connect with new investigations and methods extending altimetry-based seabed models up onto the continental shelves. Continue efforts focused on determining bathymetry from satellite based-remote sensing for shallow muddy and turbid waters. - Continue Inner Shelf Processes studies of non-hydrostatic modeling of inner shelf processes, including internal waves and fronts. Initiate a systematic study of biases introduced into the inner shelf sea-surface-temperature field by the global ocean and atmospheric models. - Continue Remote Sensors optimization studies of adaptive sampling in the littorals using small unmanned platforms (air, surface, submerged). - Continue Optics studies of underwater image prediction.					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue Sonar technology development to observe and map bottom currents and bathymetry from drifting, bottom- following sensors. - Continue research into exploiting various geoscience and optical environmental phenomena in the littoral ocean we will investigate and develop a novel remote sensing technology by exploring advanced machine learning methods for multi- spectral (optical and passive microwave) satellite observations to provide a high-resolution, holistic land surface analysis of surface vegetation and soil parameters and quantify their impact on numerical weather prediction (NWP) models. - Continue to build capabilities to predict topographic changes in sandy, coastal environments impacting traffic capability. - Continue to conduct research into exploiting various geoscience and optical environmental phenomena in the littoral ocean that will be investigated to develop a novel remote sensing technology by exploring advanced machine learning methods for multi-spectral (optical and passive microwave) satellite observations. This will provide a high-resolution, holistic land surface analysis of surface vegetation and soil parameters and quantify their impact on numerical weather prediction (NWP) models. Continue to build capabilities to predict topographic changes in sandy, coastal environments impacting trafficabiity. -Continue to focus on the development of suitable atmospheric correction, calibration, and optical inversion algorithm methods for the emerging and rapidly growing nano and microsatellite technologies. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The decrease from FY22 to FY23 is from the decreased usage of small unmanned platforms (air, surface, submerged) during optimization studies of adaptive sampling in the littorals.					
Title: Marine Mammals and Biology ***Description:*** The goal of the Marine Mammals and Biology activity focus is to better understand and characterize the effects of underwater sounds produced by Navy acoustic sources on marine mammals. Studies address characterizing marine mammal and their ecosystems, quantifying effects of sound exposure	3.462	3.543	3.589	0.000	3.589

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
on marine mammals, and improving the ability to monitoring and detect marine mammals in the open ocean. Research results supports Navy environmental compliance information needs and facilitates acquiring Letter of Authorizations from regulators that enable all Navy training and testing operations, and the development of appropriate state-of-the-art mitigation measures. ***FY 2022 Plans:*** This focus area conducts applied research in areas including monitoring and detection, integrated ecosystem, and effects of sound on marine mammals. - Passive Acoustics: Continue research efforts on passive acoustics and other technology, including the development and testing of new autonomous hardware platforms and signal processing algorithms for detection, classification, and localization of marine mammals. Continue research using animal tagging and passive acoustic monitoring to quantify behaviors, movement and distribution of marine mammals relative to key biotic and abiotic environmental properties. - Sound Effects Modeling: Continue research to quantify the behavioral and physiological effects to potentially population-level consequences of sound exposure on marine life. - Marine Mammals: Continue research to design equipment and capability to quantify the gas management and kinetics in marine mammals to elucidate the mechanisms that enable marine mammals to dive to deep depths. - Sound Reception Mechanisms in whales: Continue to pursue research to advance our understanding of sound reception mechanisms in large whales including the anatomy surrounding the ear and the whole head. - Sonar Exposure: Continue research into the stress response of marine mammals to sonar exposure with an emphasis on quantifying the effects of prolonged exposure effects on immune system suppression, reproductive failure, accelerated aging, and slowed growth. - Marine Mammal Behavior: Continue research on potential effects of Navy sources on marine mammal behavior, life functions, vital rates and population level effects.					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Environmental Compliance: Continue ongoing research to provide tools to support environmental compliance efforts and decision making related to how marine mammals can be affected by anthropogenic sounds. ***FY 2023 Base Plans:*** - Continue Sound Effects Modeling research to quantify the behavioral and physiological effects to potentially population- level consequences of sound exposure on marine life. - Continue Marine Mammals research to design equipment and capability to quantify the gas management and kinetics in marine mammals to elucidate the mechanisms that enable marine mammals to dive to deep depths. - Continue Sound Reception Mechanisms in whales effort to conduct research to advance our understanding of sound reception mechanisms in large whales including the anatomy surrounding the ear and the whole head. - Continue Sonar Exposure research into the stress response of marine mammals to sonar exposure with an emphasis on quantifying the effects of prolonged exposure effects on immune system suppression, reproductive failure, accelerated aging, and slowed growth. - Marine Mammal Behavior: Continue research on potential effects of Navy sources on marine mammal behavior, life functions, vital rates and population level effects. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** No significant increase from FY22 to FY23.					
Title: Marine Meteorology ***Description:*** The Marine Meteorology activity develops observing technologies, predictive 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-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.	11.472	12.016	14.647	0.000	14.647

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
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 2022 Plans:*** -Data Assimilation and Modeling: Continue collection of field observations; theoretical analyses; and development of data assimilation and modeling technologies. Initiate Unified Data Assimilation initiative to improve data assimilation technologies across the atmosphere, ocean, wave, and sea ice sub-disciplines. -Through the Sensor systems: Continue applied research and studies aimed at increasing knowledge content of data from remote sensing and through-the-sensor systems as well as improving the representation of dynamical and physical processes, coupled atmosphere/ocean/wave/ice/land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. These studies include efforts to develop appropriate techniques to obtain atmospheric environmental data from airborne and space-borne sensors. -Tactical Decision Aids: Continue efforts focused on parameters that affect EO and EM propagation in the marine environment with the goal of representing the real current and forecast atmosphere in tactical decision aids. Extend research of boundary layer processes, focusing on impact to state variables and their gradients. Initiate improved characterization of clouds, aerosols, and optical turbulence as they affect propagation of high energy laser systems. -Numerical Weather Prediction: Continue applied research to improve and optimize the Navy's regional and global numerical weather prediction systems by increasing resolution and incorporating new physics and numerical methods to provide much more accurate forecasts from the Tropics to the Arctic. Conduct applied research on a next-generation global model that incorporates efficient numerical methods, variable resolution grids, improved representation of physics, and that can operate efficiently on future computational systems. -Tropical Cyclone Forecast Models: Continue to develop and improve tropical cyclone forecast models to more accurately predict the rapid intensification of strong tropical cyclones. As these capabilities mature, shift focus into increasing ability to leverage better observing data, data assimilation techniques, and algorithmic analysis of storm structure and character to better understand and predict phenomenology.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
-Atmospheric Prediction: Continue efforts on the design, performance, analysis and underlying theory of global-to-tactical scale numerical simulations specifically designed to represent atmospheric environmental processes and phenomena. -Initiate how the land surface impacts predictability of boundary layer processes on weather from weekly to sub-seasonal timescales using Navy atmospheric models and predictability tools to quantify feedbacks and affects. ***FY 2023 Base Plans:*** - Initiate exploration of utilizing fleet EO/IR sensors to estimate the aerosol, water vapor, and turbulent structure of the atmosphere for quantifiable state estimation and prediction for high energy laser applications. - Initiate the development of new decision aids that take weather and climate extremes into account for improved ship routing, fuel efficiency, and bases and infrastructure protection and optimization. - Initiate the development of utilizing low order models based on machine learning techniques to provide advanced computational efficiency for large member ensemble prediction systems. - Initiate a study on forecast skill as a function of lead time across model approaches for seamless decision support from hours to years. - Initiate how the land surface impacts predictability of boundary layer processes on weather from weekly to sub-seasonal timescales using Navy atmospheric models and predictability tools to quantify feedbacks and affects. Data Assimilation and Modeling: Continue collection of field observations; quality control and process oriented analyses; and development of data assimilation and modeling technologies. Continue Unified Data Assimilation initiative to improve data assimilation technologies across the atmosphere, thermosphere, ocean, wave, and sea ice sub-disciplines - Through the Sensor systems: Continue applied research and studies aimed at increasing knowledge content of data from remote sensing and through-the-sensor systems as well as improving the representation of dynamical and physical processes, coupled atmosphere/thermosphere/ocean/wave/ice/land processes, atmospheric predictability, and methodologies for probabilistic forecasting and characterization of uncertainty. These studies					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
include efforts to develop appropriate techniques to obtain atmospheric environmental data from airborne and space-borne sensors. -Tactical Decision Aids: Continue efforts focused on parameters that affect Radar, Radio Communications, Imaging Sensors, and Laser propagation in the marine environment with the goal of representing the real current and forecast atmosphere in tactical decision aids. - Continue to extend research of boundary layer processes, focusing on impact to state variables and their gradients. - Continue improved characterization of clouds, aerosols, and optical turbulence as they affect propagation of high energy laser systems. - Numerical Weather Prediction: Continue applied research to improve and optimize the Navy's regional and global numerical weather prediction systems by increasing resolution and incorporating new physics and numerical methods to provide much more accurate forecasts from the Tropics to the Arctic. Conduct applied research on a next-generation global model that incorporates efficient numerical methods, variable resolution grids, improved representation of physics, and that can operate efficiently on future computational systems. - Tropical Cyclone Forecast Models: Continue to develop and improve tropical cyclone forecast models to more accurately predict the rapid intensification of strong tropical cyclones. As these capabilities mature, shift focus into increasing ability to leverage better observing data, data assimilation techniques, and algorithmic analysis of storm structure and character to better understand and predict phenomenology. - Atmospheric Prediction: Continue efforts on the design, performance, analysis and underlying theory of global-to-tactical scale numerical simulations specifically designed to represent atmospheric environmental processes and phenomena. - Continue to investigate how the land surface impacts predictability of boundary layer processes on weather from weekly to sub-seasonal timescales using Navy atmospheric models and predictability tools to quantify feedbacks and affects.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue to improve Naval simulation and prediction capabilities of the dynamic and thermodynamic processes in the atmosphere and ocean on a wide spectrum of scales, and to quantify and better represent the uncertainty in these predictions. This includes improvements to the forecast models, as well as improvements to ensemble forecast systems, which provide uncertainty estimates of forecasts and probabilistic predictions of particular events. As the Navy conducts a significant portion of its operations near the ocean surface up to a height of several thousand feet above the surface, in a region typically known as the atmospheric boundary layer, it is critical that our simulation and prediction capabilities of the dynamic and thermodynamic processes in this region, as well as new and emerging observational capabilities such as unmanned vehicles, are accurate. ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The Increase from FY22 to FY23 of $2.631M is for a new effort focused on developing decision aids that take weather and climate extremes into account for improved ship routing, fuel efficiency, and bases and infrastructure protection and optimization.					
Title: National Oceanographic Partnership Program (NOPP) ***Description:*** This activity focuses on Navy investments in the National Oceanographic Partnership Program (NOPP). NOPP, established by the US Congress (Public Law 104-201) in FY97, is a unique collaboration among U.S. 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, reduces costs, or both. NOPP topics address scientific problems that cross agency missions, fall in gaps between agencies or are too large for any single agency to fund. ***FY 2022 Plans:*** -National Oceanographic Partnership Program (NOPP): NOPP focus areas include topics of interest to multiple federal agencies that share ocean-related missions and are effectively investigated via partnerships. Topics include ocean, atmosphere, and coastal dynamical process studies; development of sensors, communications, and data acquisition approaches and methodologies for ocean research; modernization of ocean research and observation infrastructure; and studies of soundscapes in the ocean related to marine mammal research.	8.687	8.893	9.007	0.000	9.007

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
-Oceanographic Observations and Modeling: Continue oceanographic studies focused on model verification, constraint of boundary conditions and fluxes of mass, heat and momentum across them (air-sea, deep ocean-seabed, land-sea), and responses to storm and/or persistent forcing. -Space Based Sensors: Continue the development and utilization of small space-based sensors for oceanographic and atmospheric dynamics research. - Next Generation Oceanographic sensors: Continue development of miniaturized, low- power, next generation sensors for ocean measurements including soft materials. -Initiate hurricane coastal impact forecasting, including space-based remote sensing for multi-dimensional digital elevation models, suitable to initialize and ground-truth forecasts.. ***FY 2023 Base Plans:*** - Continue National Oceanographic Partnership Program (NOPP) to focus topics of interest to multiple federal agencies that share ocean-related missions and are effectively investigated via partnerships. Topics include ocean, atmosphere, and coastal dynamical process studies; development of sensors, communications, and data acquisition approaches and methodologies for ocean research; modernization of ocean research and observation infrastructure; and studies of soundscapes in the ocean related to marine mammal research. - Continue Oceanographic Observations and Modeling studies focused on model verification, constraint of boundary conditions and fluxes of mass, heat and momentum across them (air-sea, deep ocean-seabed, land-sea), and responses to storm and/or persistent forcing. - Continue Space Based Sensors effort for the development and utilization of small space-based sensors for oceanographic and atmospheric dynamics research. - Next Generation Oceanographic sensors: Continue development of miniaturized, low- power, next generation sensors for ocean measurements including soft materials. - Continue hurricane coastal impact forecasting, including space-based remote sensing for multi-dimensional digital elevation models, suitable to initialize and ground-truth forecasts. ***FY 2023 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** No significant increase from FY22 to FY23.					
Title: Task Force Ocean (formerly Ocean Acoustics) ***Description:*** The Task Force Ocean activity focuses on the impact of the natural ocean environment on acoustic wave phenomena in support of 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 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. This activity will also focuses on efforts addressing research needs identified by Task Force Ocean that will enable tactical maneuver for the future submarine force. The efforts funded by this Program Element (PE) fall generally into two topic areas: Analysis and understanding of the impact of environmental conditions on sonar data, and the development of reduced order ocean-acoustic models to enable environmental awareness and prediction on forward platforms. ***FY 2022 Plans:*** - Anti-Submarine Warfare: Continue to conduct applied research developing 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 - Sensors: Continue to provide Anti-Submarine Warfare (ASW) sensor and system performance models, realistic simulations, and measures of effectiveness. This includes incorporating and exploiting critical environmental knowledge and requires coupling ocean dynamics and acoustics, ambient noise characterization in the littorals. It also includes applied research in 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. Conduct research efforts to enable environmental awareness and tactical exploitation of the environment by forward naval platforms. Activities will include the development of technologies and algorithms to incorporate in situ environmental sensing into an on-scene	15.107	23.614	27.328	0.000	27.328

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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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
environmental characterization capability, inversion of sensor data to infer the local environment, and the development of capabilities to exploit the ocean environment for tactical advantage. Research efforts are informed by activities conducted by Task Force Ocean, which involve academic researchers, industry partners, and the operational Navy. - Passive Sonar: Continue to further 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. - Environmental Acoustics: Continue development of ensemble prediction products that exploit improved computational speeds for both underwater and atmospheric acoustics. - Sensors: Continue development of improved performance prediction products that exploit emerging space based sensing/characterization for rough bubbly surface boundaries. - Continue efforts that will lead to in-situ estimation of environmental parameters; optimized sensing and behaviors by adapting in dynamic and uncertain environments; and capturing uncertainty in system performance prediction and tactical decision aids for ASW, MIW, and Seabed Warfare. - Continue development of parameterizations to predict the contribution from breaking waves to acoustic ambient noise, quantifying the increased accuracy vice using wind speed alone. - Initiate new efforts centered on intensive data collection and modeling of a specific region of the ocean that will be chosen to balance scientific and operational priorities. Specific efforts will focus on improved understanding of the complex relationships amongst a large number of ocean processes and variables that include sound propagation, ambient sound, ocean and atmosphere physical processes, and biological communities. The objectives to achieve include development of innovative tools that provide insight into uncertainty that may be suitable for transition to tactical decision aids. Objectives also include prototype development of new sensors and systems that address ocean observing and exploitation requirements from Naval Oceanography at large to the unit level, as well as novel exploitation of existing sensing infrastructure. Coupled/hybrid assimilation techniques that leverage a combination of numerical modeling and AI/ML will also be developed and tested					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
using a variety of approaches including through the sensor collection and real time analysis.that exploit emerging space based sensing/characterization for rough bubbly surface boundaries. ***FY 2023 Base Plans:*** - Continue efforts centered on intensive data collection and modeling of the Atlantis II region of the New England Seamounts, The area was chosen to balance scientific and operational priorities. Specific efforts will focus on improved understanding of the complex relationships amongst a large number of ocean processes and variables that include sound propagation, ambient sound, ocean and atmosphere physical processes, and biological communities. The objectives to achieve include development of innovative tools that provide insight into uncertainty that may be suitable for transition to tactical decision aids. Objectives also include prototype development of new sensors and systems that address ocean observing and exploitation requirements from Naval Oceanography at large to the unit level, as well as novel exploitation of existing sensing infrastructure. Coupled/ hybrid assimilation techniques that leverage a combination of numerical modeling and AI/ML will also be developed and tested using a variety of approaches including through the sensor collection and real time analysis. - Continue Anti-Submarine Warfare effort to conduct applied research developing 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 Sensors development to provide Anti-Submarine Warfare (ASW) sensor and system performance models, realistic simulations, and measures of effectiveness. This includes incorporating and exploiting critical environmental knowledge and requires coupling ocean dynamics and acoustics, ambient noise characterization in the littorals. It also includes applied research in 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. Conduct research efforts to enable environmental awareness and tactical exploitation of the environment by forward naval platforms. Activities will include the development of technologies and algorithms to incorporate in situ environmental sensing into an on-scene environmental characterization capability, inversion of sensor data to infer the local environment, and the development of capabilities to exploit the ocean environment for tactical advantage. Research efforts are informed by activities conducted by Task Force Ocean, which involve academic researchers, industry partners, and the operational Navy.					

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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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue Passive Sonar work to further 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. - Continue Environmental Acoustics development of ensemble prediction products that exploit improved computational speeds for both underwater and atmospheric acoustics. - Continue Sensors development of improved performance prediction products that exploit emerging space based sensing/ characterization for rough bubbly surface boundaries. - Continue efforts that will lead to in-situ estimation of environmental parameters; optimized sensing and behaviors by adapting in dynamic and uncertain environments; and capturing uncertainty in system performance prediction and tactical decision aids for ASW, MIW, and Seabed Warfare. - Continue development of parameterizations to predict the contribution from breaking waves to acoustic ambient noise, quantifying the increased accuracy vice using wind speed alone. - Continue development and advances to ambient noise characterization, source property and location estimation, expansion of varied data assimilation methodologies and improvements to metrics used for such capabilities in a variety of acoustic scenarios. - Continue development of parameterizations to predict the contribution from breaking waves to acoustic ambient noise, quantifying the increased accuracy vice using wind speed alone. - Continue efforts that will lead to in-situ estimation of environmental parameters; optimized sensing and behaviors by adapting in dynamic and uncertain environments; and capturing uncertainty in system performance prediction and tactical decision aids for ASW, MIW, and Seabed Warfare ***FY 2023 OCO Plans:*** N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
The increase from FY22 to FY23 is tied to the growing scope with FY23 increase associated with the increased costs of intensive data collection and modeling of the Atlantis II region of the New England Seamounts activies initiated in FY22. This is a multi-year endeavor that ramps up with the first field effort in FY22 conducting a mini-pilot with only about a week on site. The full pilot is in 2023 and requires about a month at the seamount area, and the main experiment spans 2024 to 2025 with yearlong moorings with each phase incurring additional and increased cost as the effort progresses.					
Title: Physical Oceanography ***Description:*** The Physical Oceanography activity develops knowledge of the physics of the ocean 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 Surface Warfare, Anti-Submarine Warfare, Naval Special Warfare, and Mine and Expeditionary Warfare operations. Oceanographic field research that uses active acoustic transmissions requires modeling of the acoustic effects of sound on marine life in order to meet Navy environmental requirements. ***FY 2022 Plans:*** - Sensors: Continue to conduct testing and integration of turbulence sensors and other ocean oceanographic sensors into unmanned platforms to expand ocean sampling capabilities. Continue development of autonomous sensors and platforms for use in the Arctic ocean environment. Continue field campaigns to study ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore environments. Continue to conduct studies to develop new or enhance existing shipboard, in-situ, airborne, and space borne sensors and appropriate inversion and through the sensor techniques to obtain physical oceanographic environmental data. - Data Assimilation: Continue data assimilation development to coupled modeling approaches including air-ice-wave- ocean-land models.	10.976	11.485	10.634	0.000	10.634

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Earth System Prediction Models: Continue development of the capability to utilize Earth System Prediction Models to forecast the global ocean using ensemble prediction methods to enable risk assessment with skill to 30 days. - Ocean Battlespace: Continue efforts 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 variation assimilation to maximize impact of the glider data in a high-resolution local forecast model for more accurate ocean predictions. - Task Force Ocean: Continue research coordinated with Task Force Ocean including efforts to develop new and enhance existing shipboard, in-situ, airborne, and space-borne sensors, appropriate inversion methods, and through the sensor techniques to obtain physical oceanographic environmental data in conjunction with acoustical observations. - Initiate new techniques and capabilities to improve our ability to handle the near future large amounts of ocean data (including SWO altimetry data) available for assimilation into analysis and forecast systems. This includes translating the data assimilation problem to wavelet space in order to accurately correct the model background while largely retaining the realistic fractal dynamics generated by the model physics and the sparsification of covariance matrices.					
FY 2023 Base Plans: - Continue efforts into investigating new techniques and capabilities to improve our ability to handle large amounts of ocean data (including SWOT altimetry data) available in the near future for assimilation into analysis and forecast systems. This includes translating the data assimilation problem to wavelet space in order to accurately correct the model background while largely retaining the realistic fractal dynamics generated by the model physics and the sparsification of covariance matrices. - Continue to model/simulate ocean current variability, including the deep ocean boundary providing improved ocean environmental information for Seabed Warfare. Model/simulate high-resolution coupled wave-circulation-sediment transport on multiple timescales including storm event and seasonal timescales providing the capability to estimate environmental conditions in shallow water (<100 m) to support MIW and NSW.					

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
- Continue Sensors effort to conduct testing and integration of turbulence sensors and other ocean oceanographic sensors into unmanned platforms to expand ocean sampling capabilities. Continue development of autonomous sensors and platforms for use in the Arctic ocean environment. Continue field campaigns to study ocean processes and dynamics, ocean model development, and data assimilation from the open ocean to the nearshore environments. Continue to conduct studies to develop new or enhance existing shipboard, in-situ, airborne, and space borne sensors and appropriate inversion and through the sensor techniques to obtain physical oceanographic environmental data. - Continue Data Assimilation development to coupled modeling approaches including air-ice-wave- ocean-land models. - Continue Earth System Prediction Models development of the capability to utilize Earth System Prediction Models to forecast the global ocean using ensemble prediction methods to enable risk assessment with skill to 30 days. - Continue Ocean Battlespace efforts 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 variation assimilation to maximize impact of the glider data in a high-resolution local forecast model for more accurate ocean predictions. - Continue Task Force Ocean research coordinated with Task Force Ocean including efforts to develop new and enhance existing shipboard, in-situ, airborne, and space-borne sensors, appropriate inversion methods, and through the sensor techniques to obtain physical oceanographic environmental data in conjunction with acoustical observations. - Continue new techniques and capabilities to improve our ability to handle the near future large amounts of ocean data (including SWO altimetry data) available for assimilation into analysis and forecast systems. This includes translating the data assimilation problem to wavelet space in order to accurately correct the model background while largely retaining the realistic fractal dynamics generated by the model physics and the sparsification of covariance matrices. ***FY 2023 OCO Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
N/A ***FY 2022 to FY 2023 Increase/Decrease Statement:*** No significant change from FY22 to FY23.					
Accomplishments/Planned Programs Subtotals	59.593	70.086	74.622	0.000	74.622

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy			Date: April 2022
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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	18.342	33.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.842

A. Mission Description and Budget Item Justification

Developed a customized integrated sensor to enable new unmanned systems data collections in complex operating environments. Tested the integrated sensor performance in various environmental conditions to identify performance expectations and performance model development.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
Congressional Add: Task Force Ocean	9.654	10.000
FY 2021 Accomplishments: Continued exploration of analytic techniques linking physical oceanographic variability with acoustic propagation, including field efforts to collect relevant data sets. The development and use of artificial intelligence and machine learning techniques for large ocean and acoustic data sets. Through-the-sensor environmental characterization, including assimilation into nested local environmental prediction models. Explored and developed advanced signal processing techniques that incorporate local ocean structure, including ambient noise characterization		
FY 2022 Plans: Continue exploration of analytic techniques linking physical oceanographic variability with acoustic propagation, including field efforts to collect relevant data sets. The development and use of artificial intelligence and machine learning techniques for large ocean and acoustic data sets. Through-the-sensor environmental characterization, including assimilation into nested local environmental prediction models. Explored and developed advanced signal processing techniques that incorporate local ocean structure, including ambient noise characterization		
Congressional Add: Navy Special Warfare Superiority in Underseas and Maritime Environments	4.827	0.000
FY 2021 Accomplishments: Conducted applied research supporting Navy Special Warfare Superiority in Underseas and Maritime Environments.		
FY 2022 Plans: N/A		
Congressional Add: Ocean Acoustics for Monitoring	3.861	0.000
FY 2021 Accomplishments: Conducted applied research supporting Ocean Acoustics for Monitoring.		
FY 2022 Plans: N/A		
Congressional Add: Climate change hydraulic modeling risk analysis	0.000	1.500

Exhibit R-2A, RDT&E Project Justification: PB 2023 Navy		Date: April 2022
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602435N / *Ocean Wrfghtg Env Applied Res*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022
FY 2021 Accomplishments: N/A ***FY 2022 Plans:*** Conduct climate change hydraulic modeling risk analysis applied research		
Congressional Add: Continuous distributed sensing systems ***FY 2021 Accomplishments:*** N/A ***FY 2022 Plans:*** Conduct applied research in continuous distributed sensing systems	0.000	5.000
Congressional Add: Research vessel cyber infrastructure improvements ***FY 2021 Accomplishments:*** N/A ***FY 2022 Plans:*** Conduct research vessel cyber infrastructure improvements for applied research	0.000	4.000
Congressional Add: Ocean acoustics ***FY 2021 Accomplishments:*** N/A ***FY 2022 Plans:*** Conduct applied research in ocean acoustics	0.000	8.000
Congressional Add: Operational demonstration of commercially available, long endurance USV ***FY 2021 Accomplishments:*** N/A ***FY 2022 Plans:*** Conduct basic research supporting the operational demonstration of commercially available, long endurance USV	0.000	5.000
Congressional Adds Subtotals	18.342	33.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A