EXHIBIT 17

REPRESENTATIVE TASK ORDERS (RTOS) 1-3

OCEAN COLOR IV

RFP NNG12393693R

TASK 1: OCEAN BIOLOGY PROCESSING GROUP

A major functional area within the Ocean Ecology Branch (OEB) is the Ocean Biology Processing Group (OBPG). NASA's primary goal for the OBPG is to produce high-quality global ocean biological and biogeochemical data products from satellite observations, and to ensure the continuity and consistency of that time-series over multiple missions to enable studies in global change, carbon cycle research, and marine ecosystem monitoring activities. The OBPG represents an integration of data acquisition, calibration and validation, data processing, data archival and distribution functions, and analysis tools and user support within one co-located group. This diversity of roles reflects NASA Headquarters strategy for a "missions to measurements" scenario that facilitates the development of consistent data sets across missions needed for climate data records. The OBPG is responsible for the production, distribution, and quality control of ocean color (OC) products from various spaceborne radiometers, including NASA's Moderate Resolution Imaging Spectroradiometers (MODIS) currently operating on the Terra and Aqua satellites, the Sea-Viewing Wide Field-of-view Sensor (SeaWiFS), and the Coastal Zone Color Scanner (CZCS). The OBPG also supports NASA's collaborative OC activities with various international missions, which currently includes Japan's Ocean Color and Temperature Scanner (OCTS), Europe's MEdium Resolution Imaging Spectrometer (MERIS), and India's Ocean Color Monitor 2 (OCM2). Ocean color products include, but are not limited to, water-leaving radiance or reflectance, chlorophyll concentration, particulate organic and inorganic carbon concentration, and photosynthetically active radiation. To see the range of standard and experimental ocean color products currently produced by the OBPG, see the Level-3 browser on the Ocean Color Web (OCW, http://oceancolor.gsfc.nasa.gov/). The OBPG is also responsible for producing the Sea Surface Temperature (SST) products from MODIS. One of the most critical activities of the OBPG is to perform periodic reprocessings for the full suite of ocean color sensors, to incorporate advancements in algorithms, new products, or improved calibrations. See http://oceancolor.gsfc.nasa.gov/WIKI/OCReproc.html for a history of major reprocessing events. It is anticipated that one full multi-mission reprocessing of NASA ocean color missions (MODIS, SeaWiFS, CZCS) and some international missions (OCTS, MERIS) will occur within the time-frame of this task order.

1. **Sensor Calibration.** The Contractor shall provide algorithms, coefficient updates, and guidance as needed to ensure accurate radiometric calibration of all NASA spaceborne ocean color sensors over their respective lifespans. This will include interfacing with mission-specific calibration teams such as the MODIS Calibration Support Team (MCST) and other agencies such as the National Institute of Standards and Technology (NIST) to share information and advance the state of the art. The Contractor shall also maintain a working knowledge of the methods used by non-NASA missions, and contribute to international collaborations as directed.
   - **1.1. Prelaunch calibration and characterization.** The Contractor shall maintain a full understanding of the radiometric calibration and laboratory characterization results and procedures employed for all NASA ocean color sensors, and provide guidance as to potential error sources related to sensor design and performance and the quality of prelaunch analyses. Knowledge gained from prelaunch characterization, in combination

with on-orbit calibration data, will be used to improve on-orbit radiometric calibration.

1.2. On-orbit calibration. The Contractor shall maintain the calibration of the satellite sensors over time and space, based on analysis of on-board calibration measurements (e.g., lunar and/or solar calibration data). The Contractor shall investigate alternative interpretations of the on-board calibration data, and propose new strategies for improving sensor calibration stability. For MODIS, the Contractor shall attend routine meetings with MCST to share assessment of MCST calibrations and alternative OBPG methods, with emphasis on the impact to ocean color retrievals. For all sensors, the Contractor shall re-evaluate the temporal calibration prior to any major reprocessing, document findings, and incorporate any new insights into a revised calibration strategy.

1.3. Cross-calibration. In some cases, the on-board calibration data has been shown to be insufficient to fully characterize changes in radiometric performance, and methods must be developed to augment the on-board calibration with earth observation data (e.g., flat fielding or cross-calibration techniques). The OBPG currently relies on SeaWiFS Earth observations to improve the radiometric characterization of MODIS on both Terra and Aqua, but SeaWiFS is no longer available and a new approach must be developed. The Contractor shall investigate alternative approaches to maintain the temporal and spatial (cross-scan) calibration and polarization sensitivity knowledge of MODIS on Terra and Aqua, and develop a method for operational use that can maintain the consistency of the MODIS ocean color time-series into the foreseeable future.

1.4. Vicarious calibration. For all ocean color sensors supported by the OBPG, the Contractor shall provide vicarious calibration updates to minimize absolute bias in ocean color radiometry relative to ground truth. This includes identification of best available ground-based measurements to use in vicarious calibration of each mission, processing and quality control of the in situ radiometry, match-up of field radiometry with satellite sensor radiometry, and derivation of calibration adjustments required to minimize bias in the match-ups. The Contractor shall repeat this analysis prior to any major mission reprocessing, and more often to support testing of new processing algorithms and revised instrument calibrations, and to support NASA collaborations with international partners and missions.

1.5. MOBY uncertainty analysis. The Marine Optical Buoy (MOBY) has historically been used as a vicarious calibration source for MODIS and SeaWiFS. The Contractor shall perform vicarious calibrations and associated sensitivity studies on SeaWiFS and MODIS to assist with a NASA-NIST collaboration to estimate uncertainties, evaluate impact to satellite retrievals, and minimize error in the historical MOBY measurements.

1.6. ROLO model maintenance and operation. The Robotic Lunar Observatory (ROLO) model, which was developed and is maintained by the US Geological Survey (USGS)**,** is used in the analysis and interpretation of the satellite lunar calibration data. The Contractor shall interface with USGS to maintain the model, and apply it in support of ocean color calibration activities.

2. Science Software and Algorithm Development. The Contractor shall maintain and enhance the science data processing software that converts raw satellite-sensor observations (Level-0 or Level-1A) to calibrated, geo-referenced observations (Level-1B), surface radiometry and

derived geophysical products (Level-2), and multi-day binned and mapped global composites (Level-3). This chain of processing codes and related utilities, spanning over 100 compiled executables and 500000 lines of code in a mixed C, C++, and Fortran environment, is in a state of continuous evolution in response to changing NASA requirements.

2.1. Atmospheric Radiative Transfer Modeling. The Contractor shall perform the radiative transfer calculations required to generate look-up tables that model the effects of molecular and aerosol scattering in the atmosphere, including polarizing effects of the atmosphere and surface on the at-sensor radiances, for the spectral bands and radiant path geometries encountered by the satellite sensors. A primary focus of this task element is to develop advanced aerosol models that better represent atmospheric measurements (e.g., AERONET), with the goal of improving the quality and consistency of water-leaving radiance retrievals under varying aerosol loads and aerosol types, including absorbing aerosols.

2.2. Atmospheric correction algorithm development. For all NASA ocean color missions, the OBPG has primary responsibility for the maintenance and enhancement of the atmospheric correction algorithm that converts at-sensor radiances to water-leaving radiances. The Contractor shall maintain a comprehensive knowledge of the methods that represent the current state of the art, and implement and evaluate alternative approaches (proposed by OEB staff or the research community) with the goal of improving ocean color retrievals from satellite sensor observations. This includes development of corrections for scattering and absorption by aerosols, scattering by air molecules, and absorption by atmospheric gases. This also includes development of methods to normalize the water-leaving radiances for variations in solar path geometry and atmospheric attenuation of the solar irradiance, with emphasis on both open-ocean and coastal environments.

2.3. Bio-optical algorithm development. For all NASA ocean color missions, the OBPG currently maintains the standard algorithms for chlorophyll concentration and marine diffuse attenuation, and is working to develop a community-consensus algorithm for deriving inherent optical properties (i.e., total and constituent water absorption and scattering coefficients). The Contractor shall maintain and enhance these standard algorithms, and investigate alternative algorithms proposed in the scientific literature, with the goal of improving the quality of bio-optical products produced from satellite ocean color retrievals. This includes maintenance and enhancement of the NASA bio-Optical Marine Algorithm Data set (NOMAD) that contains the field measurements utilized in the derivation and evaluation of bio-optical algorithms within the OBPG and by the international research community.

2.4. Software development and maintenance. The Contractor shall implement new algorithms and capabilities into the science data processing chain as directed by the task initiator to support changing NASA priorities, new missions, and new algorithms and products proposed by OBPG staff, the mission Science Teams, and the research community. A likely change during this task period will be a transition in data format from HDF to HDF5 or NetCDF4 for the standard ocean color and SST products.

2.5. Software testing. The Contractor shall develop and maintain a strict software test plan to ensure that algorithm changes perform as expected and software implementation

errors are identified before they impact distributed products.

2.6. Software configuration management. The Contractor shall develop and maintain a software configuration management plan to ensure that all modifications of software and processing parameters can be tracked and errors can be corrected or reverted.

3. Field Data Archival and Quality Control. All researchers supported by the NASA Ocean Biology and Biogeochemistry Program (OBB) to collect in situ atmospheric and bio-optical data are required to submit the data to the OBPG for archival in the SeaWiFS Bio-optical Archive and Storage System (SeaBASS). SeaBASS currently includes data from several thousand cruises and hundreds of thousands of stations, and typically receives new submissions from one to ten investigators each month. SeaBASS utilizes a relational database and provides a user interface that allows users to query the database for very specific information (inherent and apparent optical properties, biological parameters, atmospheric properties, hydrographic variables, time, location, etc.).

3.1. SeaBASS maintenance. The Contractor shall maintain the SeaBASS archive and submission system, and process and quality control the data before incorporating it into SeaBASS. The processing includes the derivation of water leaving radiance, surface reflectance, and diffuse attenuation from the optical profile data as well as surface reflectance from above surface observations. The Contractor shall diagnose and quantify possible sources of error in the data and derived products and recommend improvements and corrections to data providers. The Contractor shall complete the processing and quality control within one month of any new submission.

3.2. SeaBASS user support. The Contractor shall provide assistance to data providers and users to support data submission and exploitation of SeaBASS for NASA funded research. This level of user support is typically required no more than two times each month.

3.3. Archive expansion. The Contractor shall investigate holdings of bio-optical field data that exist in other US and international institutions and develop and maintain a catalog of such holdings, including information on access and restrictions. The Contractor shall analyze these external holdings in relation to SeaBASS holdings and recommend acquisition or data sharing arrangements for any data that would significantly enhance the algorithm development or satellite product validation utility of the OBPG's in situ archive.

4. Product Validation and Quality Control. The OBPG is responsible for assessing the quality of all standard ocean color products that NASA distributes. The Contractor shall perform these assessments immediately prior to any, and inform the science community as to any change in quality prior to distribution. These analyses will also be performed by the Contractor to support the evaluation of proposed new products and algorithms (typically 5 to 20 times per year) or proposed modifications of sensor calibration (typically 5 to 20 times per year), and report these results to NASA. The Contractor shall also perform and report results for routine analyses of the operational product stream (on a monthly basis) to assess the quality of the MODIS time-series as new data is acquired and processed. Methods of assessment include match-up analyses, regional time-series analyses, sensor stability assessment, and sensor to sensor comparative analyses as described below.

4.1. Match-up analyses. The Contractor shall perform match-up analyses to assess

agreement between satellite products and in situ measurements.

4.2. Regional time-series analyses. The Contractor shall utilize in situ bio-optical time-series to characterize regional variations in bio-optical properties and assess temporal and absolute consistency between satellite products and measured trends.

4.3. Sensor stability assessment. The Contractor shall perform time-series analyses of the ocean color products on regional and global scales to assess temporal stability and identify potential instrument calibration artifacts.

4.4. Sensor to sensor comparative analyses. The Contractor shall produce comparative analyses of ocean color time-series derived from different sensors, including NASA and international sensors, to assess consistency, provide insight to direct sensor calibration and algorithm improvement efforts, and guide data merging activities aimed at producing global, multi-decadal-scale climate data records.

4.5. Method development. The Contractor shall propose and develop methods for estimating accuracy, precision, and stability of the ocean color products.

4.6. Algorithm and Product Evaluation. One of the principal roles of the OBPG is the objective evaluation and comparison of bio-optical and atmospheric correction algorithms and derived products developed by NASA funded researchers or the larger research community. The Contractor shall provide evaluations of these non-standard algorithms and provide recommendations as to the inclusion into routine data production.

5. Ancillary Data Support. The Contractor shall produce ancillary data products to support the ocean color and SST data processing activities. Ancillary data are acquired from sources other than the primary satellite data stream, e.g., meteorological data centers such as the National Center for Environmental Prediction, and include information such as surface pressure and wind fields, atmospheric gas concentrations, and sea ice concentrations.

5.1. Identification of sources. The Contractor shall identify the optimal sources of ancillary data as needed to support the ocean color and SST processing activities, with the goal of maximizing accuracy while minimizing discontinuities or data gaps. These sources may change over time as requirements change, current sources are discontinued, or new sources become available. The Contractor shall provide recommendation as to the best single source for each ancillary data field, and document the rational for the decision as well as the specifications required to access the data source.

5.2. Ingest and processing. The Contractor shall develop, maintain, and operate software to ingest the ancillary data sources and perform time and space interpolation of the ancillary fields to coincide with each satellite observation. The Contractor shall develop strategies for filling missing data, including spatial or temporal gaps, to maximize continuity and consistency over time and space, incorporate these strategies into the processing software, and document the basis for the decisions.

5.3. **Quality control.** The Contractor shall perform routine analysis of the ancillary sources and processed ancillary fields to ensure that quality is maintained, and implement immediate remedies (e.g., switch to alternate sources) when primary data sources become unreliable or non-optimal.

6. **Data Processing and Distribution.** The data processing activities of the OBPG are performed by a database-controlled processing system that minimizes operator interaction and automates as many functions as possible, e.g., data acquisition from the ground stations, interaction with the calibration and validation element's quality control procedures, tracking of data granules through the level-0 through level-3 processing steps, reprocessing of data granules that fail processing steps, population of the data browse system, the archival and distribution of data, generation of special products for realtime validation field experiments, etc. The system is known as the Ocean Data Processing System (ODPS). The ODPS is also employed to support testing of algorithm modifications and complete mission reprocessing efforts. This task element must be closely coordinated with the System Administration element, which provides the computer system and networking capabilities and interfaces required for data processing. The Contractor shall maintain, enhance, and operate the ODPS, including support for multiple, simultaneous processing streams that handle real-time, reprocessed, and special evaluation processing, with careful attention to configuration control of the multiple software versions and proper allocation of system resources.
   - **6.1. ODPS management.** The Contractor shall maintain and enhance the ODPS processing control software. The processing control software handles all the operations and transformations of the raw satellite data required in generating the derived ocean color and SST products for all satellite sensors supported by the OBPG, as well as the archival and distribution of the raw and derived products. This task requires the integration of level conversion and quality control routines and procedures into an end-to-end processing stream. It also requires the development and maintenance of multiple relational databases (currently implemented using SyBASE) involved in all aspects of the processing. The Contractor shall integrate new sensor and product support as needed, and develop and implement improvements to enhance processing efficiency and reliability.
   - **6.2. Data acquisition and ingest.** The Contractor shall provide timely and reliable acquisition and ingest into ODPS for all current satellite mission data (e.g., MODIS from Terra and Aqua, MERIS). This task also includes the routine acquisition and ingest of ancillary data from sources identified under the Ancillary Data Support subtask.
   - **6.3. Data distribution.** The OBPG data products are distributed through a web-based data browse, search, and order system, as well as a web-based direct-access system. The Contractor shall maintain the distribution web pages to ensure that the available data holdings are current, and shall also monitor data delivery and distribution statistics to ensure prompt filling of all ordered data products. The Contractor shall also investigate and implement new technologies to enhance the efficiency and utility of the data distribution system.

7. **SeaDAS Development and Support.** The SeaWiFS Data Analysis System (SeaDAS) is a software package developed, distributed, and supported by the OBPG. SeaDAS is a tool for visualizing and analyzing all satellite data distributed by the OBPG, and it also provides users with the ability to process data from Level-0 through Level-3 using the same processing codes employed within the ODPS. The level conversion software is distributed as both compiled executables for Linux and Macintosh systems, as well as all source code and

build support to allow external researches to develop new algorithms and products. SeaDAS has hundreds of users at research institutions all over the world. The current SeaDAS interface is based on the Interactive Data Language (IDL). The OBPG is now seeking to update SeaDAS to a more modern, Java-based interface, while still maintaining the existing capabilities. The work to be performed under this subtask is the continued maintenance and user support for current SeaDAS, as well as the development and training of the user community for a new Java-based SeaDAS interface.

7.1. SeaDAS maintenance. The Contractor shall provide user support for SeaDAS distribution and installation, computer system configuration, update notices, and requests for information. Typically, about 40-50 user contacts (software "bug" reports, requests for help, questions, etc.) are received each month.

7.2. Processing software integration. The Contractor shall work closely with the science software development staff and ODPS to ensure that satellite data processing capabilities are properly implemented and that the SeaDAS products are consistent with standard products and formats produced by the ODPS. This includes resolution of portability issues between different operating systems.

7.3. SeaDAS development. The Contractor shall develop Java-based display and analysis capabilities for a new SeaDAS release. This includes interface design and development of technologies to support all features of current SeaDAS. The Contractor shall complete the new SeaDAS release within the period of this task order.

7.4. SeaDAS training. The Contractor shall provide user-training services, e.g. system documentation, training workshops, and training media generation and distribution. Following the release of the new Java-based SeaDAS, it is expected that the OBPG will support one 2-day training workshop in the Washington DC area during this task year, with up to 20 participants. The Contractor shall provide lectures on ocean color and SST remote sensing and a hands-on computer laboratory session using satellite data. NASA GSFC will be responsible for all costs associated with the logistics of these sessions.

8. Documentation and User Support. The OBPG places high priority on documentation and communication with the research community. The Contractor shall maintain online documentation of all processing methods and analysis results, and communicate regularly with OBPG staff and the user community through publications, presentations, and on-line media. Specifically:

8.1. Staff meetings. The Contractor will present results of calibration, validation, and algorithm development and evaluation at staff meetings, which will be held at least monthly.

8.2. Processing documentation. The Contractor shall maintain a documentation tree on the ocean color website that details the methods used in satellite ocean data processing and sensor calibrations performed by the OBPG.

8.3. Analysis documentation. The Contractor shall present results of Product Validation and Quality Control analyses for all standard and evaluation products on the ocean color website within one week from the time that new results are obtained. The Contractor shall provide analysis results for all proposed reprocessing changes prior to initiation of a reprocessing, and report any significant degradation in sensor calibration as needed to

inform the user community of potential impacts to distributed products.

8.4. Journal publication. The Contractor shall publish descriptions of innovative methods and analyses (e.g., calibration methods, algorithm advancements, changes in product quality due to reprocessing) in the refereed literature (e.g., Applied Optics, Remote Sensing of Environment). It is expected that the Contractor will publish two to four journal articles during this task year.

8.5. Conference presentations. The Contractor shall give presentations as requested by NASA at several science team meetings and conferences each year. This will likely include local meetings of the MODIS Science Team, national meetings of the NASA Ocean Biology and Biogeochemistry Program (OCRT), national and international ocean science conferences such as ASLO, AGU, and Ocean Optics, and engineering conferences such as the annual meeting of the Society of Photo-Optical Instrument Engineers (SPIE) in San Diego. It is expected that six to ten presentations shall be required during this task year.

8.6. User support forum. The Contractor shall maintain and monitor the Ocean Color Forum (http://oceancolor.gsfc.nasa.gov/forum/oceancolor/forum_show.pl). The Forum is the primary vehicle for interaction between the OBPG and the general user community, and it receives roughly 100 posts per month. The Contractor shall answer user questions within one business day of posting, and resolve issues within one week.

9. Systems Administration. This task element provides systems administration support for all government-provided computing and data storage equipment used by the OBPG. This currently includes approximately 45 Desktop and laptop systems (Linux and Macintosh), 65 dedicated ODPS processing servers (Linux), and 110 data storage servers (totaling nearly three Petabytes), as well as a high-speed internal network and external networking interfaces.

9.1. Network security. The Contractor shall understand, interpret and implement all the required network and system security procedures required by NASA/Goddard Space Flight Center.

9.2. System maintenance. The Contractor shall provide routine maintenance, data integrity, system upgrades, and problem resolution. The Contractor shall maintain all shared and non-shared computer resources and provide all required security and operating system upgrades in a timely fashion. Routine data acquisition and processing is a 24/7 automated operation, though the OEB is staffed only during daytime hours. The Contractor must be prepared to respond to off-hours situations that could result in the loss of data or lack of user access to the data distribution system

9.3. Vendor interface. The Contractor shall work closely with hardware and software providers to quickly resolve issues that are covered under system maintenance agreements. The Contractor is responsible for the tracking of all hardware maintenance and software licenses to ensure the agreements are current and cover all the production systems and peripherals (e.g., printers) and that the renewals for any agreements are done in a timely fashion so as to prevent any break in coverage.

9.4. Facilities interface. The Contractor shall work with GSFC facilities personnel on system requirements such as space, power air conditioning in the main computer facility, and networking.

9.5. Procurement Support. The Contractor shall provide procurement support for upgrades (or technical refreshment) for all shared system categories (main processing system,

desktop systems, printers, conference room systems, etc.) by researching the costs of current technologies, exploring evolving technologies, evaluating improved performance versus cost of maintenance and current performance, gathering quotations from vendors, and presenting findings to the requestor. Historically, roughly 50% of the ODPS processing servers and storage systems have been replaced or repurposed every 18 months, resulting in significant increases in storage capacity and processing throughput. The Government will evaluate the recommendations of the Contractor regarding this trade-off and establish the procurement action required.

9.6. Property management. The Contractor shall maintain an inventory of all OEB computer system property, including tagged property numbers, location, and assigned user. This inventory is to be made available to GSFC property management upon request (usually annually). The Contractor shall also coordinate the excessing of unneeded equipment through GSFC property management.

ASSUMPTIONS FOR TASK 1

1. Contractor shall bid management and administration costs for this task, along with all labor categories to perform the task.

2. Assume this task order has a period of performance of one year, however, it will be renewed annually for a total of 5 years. Please include staffing and pricing for Government Fiscal Year 2013 (Year one) only. The pricing and labor categories shall be in line with your rate matrix provided at Attachment B.

3. Assume that the unloaded cost for travel under this task order is $25,000/year.

4. Assume that the ODPS processing system (subtask 6) and associated systems hardware and software (subtask 9) are shared with two other Tasks: one supporting the NPP/VIIRS PEATE requirements and one supporting the Aquarius Mission Operations requirement of the Statement of Work.

TASK 2: ACE/PACE MISSION DEVELOPMENT

ACE is a mission focusing on aerosols, clouds, and ocean ecosystems, in response to the NRC Decadal Survey. The ACE mission is expected to launch in 2022 or later. Recently, NASA announced the data continuity PACE (Pre-ACE) mission, with a launch date of 2019 or later. PACE will contain a sensor to measure ocean color and possibly a French-contributed polarimeter for aerosol measurements. The science requirements for PACE have not yet been defined, but are expected to be similar to those of the ACE mission. See http://decadal.gsfc.nasa.gov/. The OEB is currently leading the sensor requirements development for the ocean color instrument on ACE, in anticipation of being selected to lead the formal Phase A analysis for the ocean color component of the PACE mission.

This 1-year Representative Task Order (Renewable for a total of 5 years) assumes that the PACE mission has been awarded to GSFC and that the OEB will be responsible for some specific elements of the mission, including the ocean color science requirements and the radiometric calibration analysis, product validation, and ground processing elements. Thus, it is anticipated that Contractor support will be required to meet these responsibilities. The estimated phasing of the PACE mission development (assumed relative to Contract award date) and associated Contract support needs follow. Note that Contractor support under this Task Order does not include activities of NASA Code 400 (Flight Projects Directorate) or 500 (Applied Engineering and Technology Directorate), e.g., overall project management, fabrication, or implementation of prelaunch test plans, and it does not include the detailed design or fabrication of the ocean color sensor, which is expected to be competed through a NASA Announcement of Opportunity.

Phase A: Preliminary Analysis (Year 1). The Contractor shall provide support for developing the ocean color science requirements for the PACE mission. Example activities include; a) determination of the required signal to noise ratio of the top-of-atmosphere radiances to achieve a certain accuracy for a specific ocean color product; b) performance specifications for on-board calibrators (e.g. the solar diffuser); c) selection of wavelengths to be used for the processing of a specific ocean color product; d) development of alternative methods for water vapor correction; e) inclusion of atmospheric products from the polarimeter aboard the satellite into the atmospheric correction for the ocean color products f) evaluation of different orbits of the satellite with regard to global coverage characteristics. The Contractor shall apply these analyses to support the development of an ocean color sensor and mission design and operations concept for PACE, and support the Mission Definition Review.

Phase B: Definition (Year 2). The Contractor shall support the development of component and system level verification plans, especially those related to radiometric performance and geolocation accuracy of the ocean color sensor selected for PACE. The Contractor shall support any Preliminary Design Review (PDR) as needed, as well as the system-level PDR. The Contractor shall investigate atmospheric correction and bio-optical algorithms that exploit the selected PACE instrument design.

Phase C: Design (Year 3). The Contractor shall support the refinement of system-level sensor characterization plans. The Contractor shall prepare interface documents and format

specifications for the sensor Level-0, Level-1A, and Level-1B data. The Contractor shall support any Critical Design Review (CDR) as needed, as well as the system-level CDR. The Contractor shall continue the development of atmospheric correction and bio-optical algorithms that exploit the selected PACE instrument design.

Phase D: Development (Years 4-5). The Contractor shall support any Test Readiness Reviews (TRR) as needed, as well as the System Acceptance Review and the Flight Readiness Review. The Contractor shall support the analysis of sub-system and system-level sensor characterization tests (e.g., polarization sensitivity, relative spectral response, absolute calibration, linearity, straylight, response versus scan angle, and instantaneous field-of-view) and recommend mitigation strategies in case a performance parameter is in danger of failing the requirement. (Note that the execution of instrument or component testing is expected to fall under the responsibility of NASA Code 500). The Contractor shall develop and deliver the end-to-end processing software for the ocean color radiometer on PACE, including the capability to produce global Level-1A, Level-2, and Level-3 data products. The Contractor shall enhance the functionality of the existing Ocean Data Processing System (ODPS) and OBPG data distribution facilities to support ingest of PACE data, processing to global ocean color products, and distribution.

Documentation and User Support. In each phase of mission development**,** the Contractor shall document all methods and analysis results and communicate regularly with OEB staff. The Contractor shall present results of review preparation, requirements definition, and algorithm evaluation activities at staff meetings, which will be held monthly. The Contractor shall give one or two presentations at the PACE science team meeting and one international science conference (e.g., Ocean Optics, Ocean Sciences) each year, to inform the research community and NASA Headquarters on the status and capabilities of the PACE mission to support ocean color science. The Contractor shall assist in the publication of significant results and milestones in the scientific literature (e.g., RSE, Applied Optics).

ASSUMPTIONS FOR TASK 2

5. Contractor shall bid management and administration costs for this task, along with all labor categories to perform the task.

6. Assume this task order has a period of performance of one year with an annual renewal for five years. Please include staffing and pricing for each of the 5 years, recognizing that the work evolves over time. The pricing and labor categories shall be in line with your rate matrix provided at Attachment B.

7. Assume that the ocean color sensor design is selected by NASA at the start of year 2, and the chosen concept is a hyperspectral radiometer spanning the spectral regime from 350 to 1000-nm with 1-km spatial resolution at nadir.

8. Assume that the unloaded cost for travel under this task order is $7,000/year.

TASK 3: FIELD PROGRAM SUPPORT OFFICE

To support the satellite ocean color calibration, validation, and algorithm development activities within the Branch, the OEB participates in oceanographic field campaigns and operates a laboratory at GSFC to process and analyze water samples for biological and biogeochemical constituents. The OEB requires Contractor support in two key areas.

1. **Oceanographic Field Data Collection and Processing.** The OEB requires Contractor support for oceanographic field data collection and analysis. All work will be performed on-site at GSFC or in the field using Government furnished equipment.
   - **1.1. Cruise Planning and Participation.** The Contractor shall plan and participate in one major oceanographic cruise deployment (several weeks) and two short-term domestic (US) field deployments (several days) per year. The specific cruises are to be based on priorities established in consultation with NASA HQ and the Field Program Support Office (FPSO) advisory group. These cruise activities require both domestic and international travel for planning meetings and cruise participation.
   - **1.2. Field Data Collection.** The Contractor shall perform field data collection, including water samples for post-cruise analysis, optical measurements of ocean apparent optical properties (AOPs) using both above-water and submersible profiling radiometers, as well as inherent optical properties (IOPs) such as dissolved and particulate absorption and particle scattering coefficients. Contractor expertise in deployment protocols for field instrumentation is required, including submersible and above-water radiometers.
   - **1.3. Field Data Analysis.** The Contractor shall perform post-cruise data processing and quality control of field data, including processing of radiometric profiles to derive water-leaving radiances, and analysis of collected water samples to derive parameters such as dissolved organic matter absorption and particulate organic matter concentration. Contractor expertise with a variety of laboratory instruments, such as mass spectrometers, analysis methods, and knowledge of measurement protocols for each parameter is required.
   - **1.4. Laboratory and Field Instrument Maintenance.** The Contractor shall perform routine maintenance of FPSO equipment (replacement parts, arrangements for recalibrations, etc.) and other materials required to support the field and laboratory data collection and analyses (glassware, filter pumps, shipping containers, etc.).
   - **1.5. Laboratory and Field Instrument Upgrades.** The Contractor shall maintain a familiarity with the instrumentation offerings of various ocean equipment vendors and make recommendations on procurements of such equipment and upgrades to existing hardware and software.
   - **1.6. Community Training.** The Contractor shall lead one 3-day community training session per year, to teach data collection and processing protocols to the research community. This training activity will require domestic travel for the planning meeting and the actual event. All logistical costs associated with these workshops (e.g., rental of meeting rooms) will be provided by NASA.

1.7. Communication and Publication. The Contractor shall attend NASA Programmatic meetings and Scientific Conferences as directed by the Task lead, to present the results of FPSO activities. It is anticipated that this will involve 2 to 4 trips per year for three to five Staff members. The Contractor shall document results of field data collection and analysis in NASA technical memoranda and refereed scientific journals.

2. Phytoplankton Pigment Analysis Support. The OEB houses the Phytoplankton Pigment Analysis Laboratory (PPAL). All water samples collected by NASA-approved investigators for pigment analysis are processed through the PPAL. The approved number of samples to be processed each year is 3000. Contractor support is required for operating and maintaining the PPAL and communicating results to the investigators and NASA. All work will be performed on-site at GSFC using Government furnished equipment.

2.1. Sample Acquisition. The Contractor shall coordinate the delivery of samples from external investigators in collaboration with a community point-of-contact assigned by NASA HQ.

2.2. Sample Storage. The Contractor shall store the samples following standardized shipping and sample preservation methods. The Contractor shall check the sample storage facilities at GSFC on a daily basis throughout the workweek to ensure no samples are lost because of storage equipment failures, power outages, etc. Additional automated system alerts will be monitored over weekends and holidays and appropriate actions taken in case of any problems.

2.3. Sample Analysis. The Contractor shall analyze water samples for key phytoplankton pigment concentrations using High Performance Liquid Chromatography (HPLC), following NASA-approved protocols. The Contractor shall process the data in a timely manner, based on the priority set by the community point-of-contact.

2.4. Delivery of Results. The Contractor shall provide HPLC analysis results and required documentation (date, time, location, depth, etc.) to the investigators and also submit results to SeaBASS.

2.5. Laboratory Maintenance. The Contractor shall manage the maintenance of the HPLC system and other related equipment and make recommendations on system upgrades as may be required or desirable.

2.6. Communication of Results. The Contractor shall attend key NASA-sponsored meeting such as the Ocean Biology and Biogeochemistry Program annual meeting, and report on the status of PPAL activities. It is anticipated that these activities will involve between 2 and 4 domestic trips per year for 1-2 people. The Contractor shall also document PPAL results in annual reports required by NASA HQ, and in NASA technical memoranda as directed.

ASSUMPTIONS FOR TASK 3

9. Contractor shall bid management and administration costs for this task, along with all labor categories to perform the task.

10. Assume this task order has a period of performance of one year, however, it will be renewed annually for a total of 5 years. Please include staffing and pricing for Government Fiscal Year

2015 (Year 3) only. The pricing and labor categories shall be in line with your rate matrix provided at Attachment B.

11. Assume that the unloaded cost for travel under this task order is $90,000/year.