ATTACHMENT A

STATEMENT OF WORK

Support for Atmospheric Sciences, Modeling and Data Assimilation
Draft Statement of Work

I. Scope of the Contract

This contract is for support of atmospheric science and data assimilation research conducted by Goddard Space Flight Center (GSFC) scientists in the Earth Science Division (Code 610). The contract will support the full range of research and development activities of the Earth Sciences Division-Atmospheres (Code 610AT) and of the Global Modeling and Assimilation Office (GMAO, Code 610.1), and the operational activities of the GMAO.

Code 610AT conducts a comprehensive atmospheric science research and technology development program directed towards observing, monitoring, characterizing, modeling, understanding, and advancing knowledge of the Earth's atmosphere. The research program is aimed at understanding the structure, dynamics, and radiative properties of clouds, aerosols, and precipitation; understanding atmospheric chemistry, especially the role of natural and anthropogenic trace species on the ozone balance in the stratosphere and troposphere; understanding the influence of solar variability on the Earth's climate; and advancing our understanding of the physical properties of the Earth's atmosphere including its interaction with the Earth surface. Code 610AT scientists identify requirements for atmospheric observations via orbital and sub-orbital instrumentation and missions. Scientists also conceive, design, develop, and implement optical, microwave, radar, and lidar technologies for remote sensing of the atmosphere. Scientists further conduct field measurements for satellite sensor calibration and data validation, and carry out modeling activities for atmospheric radiative transfer, climate, clouds, aerosols, chemistry and transport of trace species, and in general the development of next-generation Earth system models. This program of research provides support for GSFC to observe, monitor, explain, and predict trends in the spatial and temporal variability of the Earth's atmosphere. The research also addresses the possible consequences of these trends with respect to climate change, human health, food production, water management, and other issues of societal importance. These research activities are carried out in collaboration across GSFC organizations and with domestic and international partners in universities, private industry, and other government agencies. All of this work supports and is consistent with the NASA mission in Earth Science. This contract shall support the full scope of this GSFC Code 610AT research and technology development program for studying the Earth's atmosphere. The contract shall also support computing and software engineering efforts for NASA-funded researchers using high end computing resources. The organization of the GSFC and results of recent work are summarized in documents posted on the GSFC's web site, http://atmospheres.gsfc.nasa.gov, with annual reports that provide technical details.

The GMAO develops, operates and maintains comprehensive models and data assimilation systems for the Earth's atmosphere, ocean, cryosphere and land surface, including atmospheric constituents and ocean biogeochemistry. GMAO models and assimilation systems support NASA's Earth Science research enterprise and contribute to the nation's capabilities in climate, weather and atmospheric composition prediction. The data assimilation systems comprise the assembly, pre-processing, quality control and characterization of all the observations being assimilated, the analysis systems which combine model and observation information, and the Earth

system models required to interface with the analysis systems. The GMAO effort includes the development and implementation of advanced coupled models (ocean-atmosphere-land surface; chemistry-climate; ocean dynamics-biology, etc.) to support the assimilation systems and to address the key scientific questions and prediction goals identified by the NASA Science Mission Directorate. The GMAO collaborates with Code 610AT scientists and with the external science community in developing and validating its models and data assimilation systems. In particular, the GMAO participates in the Joint Center for Satellite Data Assimilation, collaborating with NOAA's National Centers for Environmental Prediction (NCEP) on developments for atmospheric data assimilation and on ocean data assimilation for initialization of seasonal forecasts. All models and assimilation systems are developed and implemented using the Earth System Modeling Framework (ESMF).

In order to comply with the *Section 508 Electronic and Information Technology Accessibility Standards*, the contractor shall perform all work required under this contract in compliance with the following technical standards delineated in Code of Federal Regulations (CFR) Title 36:

1194.21 Software Applications and Operating Systems
1194.22 Web-based Intranet and Internet Information and Applications

The Statement of Work (SOW) contains Core Requirements and Indefinite Delivery, Indefinite Quantity (IDIQ) functional requirements that describe the work to be performed by the contractor in terms of NASA-required outcomes and/or results. The contractor shall be responsible and accountable for achieving the required results.

I.1 Statement of Work Structure

The Core requirements are defined in Section II. The Indefinite Delivery, Indefinite Quantity (IDIQ) requirements are outlined in Sections III, IV, and V. Core requirement functions pertain only to support of the GMAO. These functions, which include GMAO operational system development and maintenance, GMAO data assimilation system (DAS) production operation, and GMAO project management and administration, are required to support IDIQ task orders.

The comprehensive atmospheric research and technology development program conducted by the Earth Science Division-Atmospheres lends itself to an IDIQ approach. The IDIQ requirements for Atmospheric Science (Code 610AT) support are outlined in Section III.

The modeling and data assimilation research and development program conducted by the GMAO also lends itself to an IDIQ approach. The IDIQ requirements for GMAO support are outlined in Section IV.

The general support requirements common to Code 610AT and GMAO also lend themselves to an IDIQ approach. These are outlined in Section V.

II. Core Requirements

II.1 GMAO Operational System Development and Maintenance

The GMAO develops, operates and maintains the Goddard Earth Observing System (GEOS) data assimilation system (DAS), currently at Version 5 (GEOS-5 DAS). The GEOS-5 DAS assimilates data from numerous space-borne, airborne and in situ platforms. The DAS provides assimilated data products to EOS instrument teams for use in their retrieval algorithms, and generates products in support of NASA field campaigns and various international projects, including routine inter-comparison with analyses and forecasts made at Numerical Weather Prediction (NWP) centers around the world. The DAS also provides reanalysis products focused on the climate record, by reprocessing historical data streams throughout the satellite era, which are openly available online through the Goddard Earth Sciences Data and Information Services Center (GES DISC). Products that support international projects and field campaigns are generally available through the data portal of the NASA Center for Climate Simulation (NCCS). Model simulations are also generated for scientific analysis and are available for collaborating scientists. A description of the current production system, including the several different data streams routinely generated for the aforementioned types of products, is available on the GMAO web site at http://gmao.gsfc.nasa.gov/products. Technical descriptions and documentation of GEOS-5 system components are available at http://gmao.gsfc.nasa.gov/GEOS, particularly at the GEOS-5 wiki accessible there. The GEOS-5 DAS includes the Gridpoint Statistical Interpolation (GSI) scheme initially developed at NOAA/NCEP and now developed jointly by GMAO and NCEP. Operating in near-real-time, GEOS-5 assimilates tens of millions of satellite and other observations per day.

The contractor shall be responsible for:

II.1.1 Developing the operational GEOS atmospheric and land data assimilation software (hereafter the GEOS systems), the operational GEOS systems test plans, test procedures and test reports for GEOS systems verification, GEOS systems evaluation, and GEOS systems operational end-to-end testing. The contractor shall support NASA instrument teams in testing of the GEOS systems upgrades by providing sample operational datasets. A major external element for the GMAO data production operation is the GES DISC, which is responsible for providing the GMAO with much of the input data sets for the GEOS product generation. The DISC is also responsible for archiving GEOS standard data products and for distributing products to users who require access through the DISC. The contractor shall work with the DISC to clarify and coordinate changes to the interface requirements for GEOS operational data products.

II.1.2 Development and maintenance of software components required to integrate upgrades to the GEOS systems into the operational environment. The typical codes to be developed are input data preprocessing, I/O routines including output data formatting (such as HDF) for external customers, job scheduling scripts, and data management scripts. The contractor shall integrate upgraded software components, and build the GEOS DAS for system verification and subsequent promotion of the systems to operations.

II.1.3 Supporting multi-year re-analyses or reprocessing assimilations using the GEOS operational systems. This support shall include identifying and preparing observations and boundary conditions and identifying their source for acquisition.

II.1.4 Providing general support to GEOS data users, external or internal, in answering questions or solving technical problems related to the use of GEOS data.

II.1.5 Maintaining software development using software configuration management (CM) tools. The contractor shall document all the system changes in requisite CM records. The contractor shall be responsible for developing, maintaining and updating the file specification document that describes the format, frequency and fields in each of the data products.

II.1.6 Providing support to the overall system performance enhancement efforts in the areas of software optimization and portability, memory utilization, I/O throughput, and data archival requirements for future releases of GMAO production systems.

II.1.7 Coordinating the management and organization of data products generated by or used in the operational systems in support of the GMAO product generation

II.1.8 The data portal in the NCCS is another mechanism for serving various GMAO products. The contractor shall work with the NCCS to ensure that the appropriate online disk cache is available for serving these products by estimating the size of the product pool using the required retention period defined by the GMAO civil service staff. Contractor staff shall also ensure that the data access policies appropriate for each product are documented.

II.2 GMAO Data Assimilation System (DAS) Production Operation

The contractor shall also:

II.2.1 Perform the near real-time data production operation of the GEOS DAS. This includes logging and reporting all anomalies encountered during the system operation monitoring. The system operation encompasses the production of analyses and forecast data products as well as GEOS DAS data reprocessing in multi-year re-analyses.

II.2.2 Update the GEOS DAS operations information daily on the GMAO web page to reflect the up-to-date status of the system. The contractor shall update the operations procedure document as needed to incorporate procedural changes due to evolving GEOS system or computing environment changes.

II.2.3 Locate, archive, prepare and provide GMAO data products and other ancillary data, e.g. data used for product verification or validation, to the GMAO data product users and developers whose data requests have been approved by the GMAO management.

II.2.4 Log all the incoming data requests by the GMAO data users. For each approved data request, the contractor shall provide an estimate of required disk space, archival space, time period for maintaining the data, and preferred route for delivering data to customers. The contractor shall prepare, format and package the requested data and make them accessible to the requester within the delivery schedule agreed with the requester.

II.2.5 Obtain, catalog and maintain ancillary data identified by the Government to be used for science research, software development, or product verification within the GMAO.

II.3 GMAO Project Management and Administration

The contractor shall also:

II.3.1 Provide high-level project management, including (i) scientific, technical and staffing coordination among the IDIQ tasks; (ii) contract resource planning to achieve GMAO work priorities; (iii) training of contract staff in areas such as high-end computing (HEC) software development, configuration management tools, shell scripting, plotting and data manipulation software tools, and statistical software; and (iv) regular meetings with the GMAO Chief to provide contract status reports and to review problems and issues, especially those that could impact delivery schedules.

II.3.2 Provide technical support to maintain the GMAO home page, the GMAO internal Web page known as the GMAO Intranet, and the GMAO extranet, including (i) maintaining GMAO Web pages in accordance with GSFC Web policy and standards and GSFC Science and Exploration Directorate requirements; (ii) assisting GMAO Web authors to comply with GMAO-approved Web policy and standards; (iii) assessing the relevancy and currency of GMAO Web material and coordinating with GMAO Web authors to update, add, and/or delete material as appropriate; (iv) posting the latest version of GMAO documents in a timely manner; and (v) staying abreast of the latest Web technology and making recommendations to improve GMAO Web pages.

II.3.3 Provide technical support to create compact summaries of GMAO activities, including (i) one-page PowerPoint slides of GMAO "Science Snapshots" that concisely describe the latest scientific and technical advances in GMAO research; and (ii) brief "Research Highlights" that typically summarize recent GMAO publications or conference presentations.

II.3.4 Provide administrative support for GMAO workshops held approximately annually, such as sending out invitations, gathering attendance lists and presentations, and coordinating visitor badges.

II.3.5 Provide financial tracking and procurement support, including (i) maintaining and tracking the actual and projected budgets of GMAO Principal Investigators in conjunction with Government Resource Analysts, (ii) maintaining an accounting of the budget and expenditures of the GMAO Assessments pool; (iii) maintaining an accounting of how the cost of each non-federal GMAO staff member is covered each fiscal year; and (iv) generation and tracking of purchase orders, communication with vendors, customers and GMAO local computing systems staff, and reconciliation of travel expenditures.

II.3.6 Provide travel support for GMAO civil servants, including (i) researching, collecting, analyzing, maintaining and tracking civil service travel requirements; (ii) front-end support such as gathering information about travel goals and dates, submitting NCTS requests, and passing all required information to Concur Government Edition (CGE) specialists as needed; and (iii) preparing electronic Document Availability Authorization (eDAA) submissions of presentation abstracts and other documentation needed for civil servant travel, such as requests to travel with government-owned computers.

II.3.7 Provide general administrative support, including (i) general office management duties; (ii) maintaining office records; (iii) preparing work requests; (iv) on-boarding new hires and visitors; (v) ordering supplies and tracking their cost; (vi) supporting GMAO seminars and conference room needs;

(vii) coordinating telephone requests; (viii) preparing shipping documents; (ix) maintaining spreadsheets, data bases and other information systems; (x) collecting and formatting weekly highlight reports; (xi) ensuring that information on GMAO personnel, procedures and publications is kept current and posted on the GMAO Web pages; (xii) providing charts for GMAO management presentations and reports; (xiii) providing technical support in the preparation of GMAO Annual Reports and/or similar documents.

III. Functional Requirements for Atmospheric Science Support

The Atmospheric Science portion of the Statement of Work is divided into four technical areas to specify the functional requirements of the contract:

1. **Instrumentation:** Requirements for supporting the design, development, testing, maintenance, calibration, and operation of orbital and sub-orbital instruments for atmospheric and solar observations. The instruments include sensors operated from the ground, and aboard aircraft, balloons, or other sub-orbital platforms, and from orbital missions on satellites and the International Space Station.
2. **Earth System Modeling, Data Processing, and Analysis:** Earth System Modeling requirements include supporting the development, testing, operation, improvement, software optimization, and documentation of computer models that describe Earth system processes including: solar spectral and total radiation, atmospheric radiative transfer, climate simulations, modeling the chemistry and transport of trace species on regional-to-global scales, cloud-resolving models, coupled land-atmosphere models, and development of next-generation Earth system models, including the coupling and integration of existing models to form novel, interdisciplinary models. Data Processing and Analysis requirements include supporting the processing and analysis of data collected by instruments observing the Earth atmosphere or solar radiation from spacecraft, sub-orbital platforms, or the ground.
3. **Documentation and Presentation:** Requirements supporting the preparation of research proposals, refereed journal publications, manuscripts for symposia proceedings, and presentations at conferences, symposia, workshops, and seminars.
4. **Mission Science:** Requirements for supporting project scientists in the formulation, implementation, and operation of satellite missions.

In practice, the atmospheric research at GSFC is collaborative and interdisciplinary. Task orders will typically overlap into multiple areas.

1.0 <u>Instrumentation:</u>

The contractor shall support the specification, design, development, maintenance, calibration, and operation of orbital and sub-orbital instruments for atmospheric and solar observations. The instruments include and are not limited to active and passive optical and microwave sensors. The contractor shall operate instruments at GSFC, on top of buildings and in mobile trailers both, at GSFC and in the field, and aboard orbital and sub-orbital platforms. The contractor shall support the processing of instrument data for the measurement of total and spectral solar radiance and irradiance and of atmospheric properties such as optical thickness, temperature, water vapor, and trace gas profiles, clouds, aerosols, precipitation, total precipitable water, total ozone burden,

boundary layer heights, and wind velocity. Supported instruments and technical equipment will include and not be limited to: the Cloud-Aerosol Transport System (CATS), the Southern Hemisphere Additional Ozonesondes (SHADOZ), the SMARTLabs multi-instrument trailer, Cloud Physics Lidar (CPL), the Airborne Compact Atmospheric Mapper (ACAM), the High Altitude Wind and Rain Airborne Profiler (HIWRAP), the lidars of the Micro-Pulse Lidar Network (MPLNET), lidar instruments within the Network for the Detection of Atmospheric Composition Change (NDACC), ground based spectrometers and radars, radio frequency reception systems for receiving data transmitted by orbiting satellites, and other similar instrumentation.

The detailed functions in support of instrumentation that are currently performed at GSFC in support of atmospheric research and development are:

1.1 Provide support to specify technologies and performance, and technical requirements for instrument design;
1.2 Provide engineering support for instrument design and development including system, mechanical, electrical, and optical engineering;
1.3 Provide mechanical and electrical system designs and drawings;
1.4 Perform structural, thermal, and optical performance analyses of instrument designs;
1.5 Design, draw, and fabricate mechanical parts for instruments;
1.6 Design, draw, and fabricate electrical boards for instruments;
1.7 Specify, design, draw and build electrical and mechanical interfaces to platforms such as mobile trailers, towers, aircraft, and balloon pallets
1.8 Test and characterize instrument performance at GSFC and in the field;
1.9 Operate, maintain and repair instruments;
1.10 Calibrate instrument response;
    1.10.1 Maintain and operate ground support equipment and calibration standards traceable to the National Institute of Standards and Technology such as irradiance lamps, integrating spheres, solar diffuser panels, and black bodies;
    1.10.2 Maintain a Class 10,000 clean room that meets ISO 9000 standards;
1.11 Support field experiments and campaigns in accordance with NASA and GSFC safety practices and regulations;
    1.11.1 Provide support to plan and schedule instrument deployments and operations in the field;
    1.11.2 Ship instruments and support equipment to and from field sites in accordance with NASA property management regulations;
    1.11.3 Install support equipment and instruments in mobile trailers, on towers, on ships and buoys, in aircraft and on balloon pallets;
    1.11.4 Operate instruments and collect data in the field, on towers, in trailers, aboard ships, and aboard aircraft;
    1.11.5 Prepare, maintain, and operate the computers and other information technology equipment necessary for operations, instrument data collection, and data processing in the field in accordance with NASA information technology (IT) security practices and requirements;
    1.11.6 Provide computer programs and the associated software upgrades and, documentation, for determining optimal aircraft flight paths for aircraft field

campaigns associated with the research efforts supported by this contract;

1.11.7 Provide investigator coordination, mission document preparation, database design and maintenance, and meeting support for investigators associated with field campaigns and satellite missions related to research efforts supported by this contract;

1.12 Support instrument data processing;

Develop and document algorithms for processing instrument data and for retrieving solar and atmospheric properties from instrument data;

1.12.1 Implement algorithms in computer software and document the code;

1.12.2 Process instrument data to create data products,

1.12.3 Distribute and provide data and data products to principal investigators, co-investigators, and collaborators;

1.13 Manage instrument laboratories in accordance with NASA safety practices and requirements;

1.13.1 Provide GSFC safety officers;

1.13.2 Ensure that all hazardous materials are stored and used properly;

1.13.3 Ensure that all GSFC equipment is located, maintained, and operated in accordance with NASA safety requirements;

1.13.4 Obtain, document, and remain current on required GSFC equipment certifications.

2.0 Earth System Modeling, Data Processing, and Analysis

While tasks in Earth System Modeling and tasks in Data Processing and Analysis are inter-related to some degree, they also have significant differences in the nature of the support work being performed. Hence, we have separated the Functional Areas into two sub-sections, 2.1 Earth System Modeling and 2.2 Data Processing and Analysis.

2.1 Earth System Modeling:

The contractor shall support the development, application, and advancement of numerical models simulating the chemistry and physics of the Earth's atmosphere. Modeling is an essential component of the research into atmospheric processes. Models help GSFC understand how the atmosphere behaves over space and time and how it interacts and is impacted by other Earth system processes including ocean circulation and human-driven emissions and land use. The contractor shall perform the following functions in support of modeling:

2.1.1 Provide support to define, develop, implement, validate, and document models describing the chemistry and physics of atmospheric and related Earth system processes;

2.1.2 Provide support to define, develop, implements, validate, and document models that synthesize atmospheric data and observations as a function of sensor design and atmospheric and surface conditions;

2.1.3 Provide support to define, develop, implement, validate, and document methodologies for assimilating data into models;

2.1.4 Write, test, compile, maintain, update and document software code and programs that implement models and modules, update models and modules, couple models, and

assimilate data into models;
2.1.5 Run and apply models for the simulation and prediction of atmospheric physical and chemical processes under different global change scenarios;
2.1.6 Run and apply atmospheric process models in support of studies exploring the impact of atmospheric change on climate, related Earth system processes, and society;
2.1.7 Run and apply models to synthesize atmospheric data and observations to develop, propose, and assess satellite system and sensor designs and operations;
2.1.8 Compare data and observations from satellite sensors and field campaigns to model simulations and predictions for model validation and understand and interpret atmospheric data, observations, and conditions;
2.1.9 Manage, organize, and provide support to analyze the data and output generated by model simulations;
2.1.10 Support the development, coupling, porting, optimization, interoperability, and use of models for research into topics including and not limited to:

2.1.10.1 Using the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model within the Goddard Earth Observing System (GEOS) general circulation model and the Weather Research Forecast-Chemistry (WRF-Chem) model to study aerosol emissions, plume heights, and transport; aerosol effects on surface radiation; aerosol vertical distributions; seasonal and inter-annual variations of dust sources; and light absorption by pollutants, biomass burning emissions, and dust aerosols;
2.1.10.2 Coupling the Combined Stratosphere-Troposphere Model (COMBO) to the GEOS general circulation model to study the interaction of the stratospheric ozone layer and climate;
2.1.10.3 Coupling models to investigate the dynamic and thermodynamic processes associated with cyclones, hurricanes, winter storms, cold rain bands, and tropical and mid-latitude deep convective systems; surface (land and ocean) effects on atmospheric convection, cloud chemistry, cloud-aerosol interactions, and stratospheric-atmospheric interactions; and cloud-climate feedback mechanisms;
2.1.10.4 Developing and maintaining a modular three-dimensional chemical transport model (CTM) to assess the impact of natural and anthropogenic perturbations on atmospheric composition and chemistry;
2.1.10.5 Implementing schemes to more realistically predict the size distribution of cloud particles (liquid and ice), aerosol optical properties, and thermal infrared radiative transfer within the GEOS general circulation model;
2.1.10.6 Simulating the photochemical mechanisms controlling the formation and behavior of ozone and other trace gases in the stratosphere and troposphere and the linkages to air quality and climate;
2.1.10.7 Applying the National Center for Atmospheric Research (NCAR) Whole Atmosphere Community Climate Model (WACCM) to study the influence of solar protons on ozone in the stratosphere and mesosphere; and
2.1.10.8 Simulating radiative transfer through the atmosphere to understand atmospheric effects on the energy balance, convection, circulation, and satellite observations;
2.1.10.9 Predicting brightness temperatures and reflectivities, as observed

by multifrequency microwave radiometers and radars, as a function of precipitation rate and relating cloud thickness, humidity, and other atmospheric conditions to precipitation rates;

2.1.10.10 Assessing the potential improvement on short and mid range weather forecast skill by assimilation of satellite-based observations.

2.1.11 Evaluate, design, develop, and implement tools to assist scientists in designing, developing, and executing research models and visualizing and analyzing the model outputs.

2.2 Data Processing and Analysis:

The contractor shall support the processing and analysis of data used to study the Earth's atmosphere. The data will come from a wide variety of instruments and sensors including and not limited to infrared and microwave atmospheric sounders, microwave radiometers, imaging multispectral ultraviolet, visible, and infrared radiometers and imaging spectrometers, radars and synthetic aperture radars, and lidars. The data may be collected from the ground, sub-orbital platforms, and satellite platforms. The data processing and analysis will support research in areas such as: sensor calibration and measurement validations; aerosol-cloud-climate interactions; atmospheric aerosol content, composition, and circulation; the atmospheric hydrologic cycle; climate variability and climate change; clouds and precipitation; global and regional trends of temperature, ozone, and trace gases; radiative transfer; Ultraviolet-B and solar irradiance measurements. The contractor shall perform the following functions in support of data processing and analysis for such research:

2.2.1 Define and document algorithms, procedures, and methodologies for reading, ingesting, reformatting, managing, processing, calibrating, and analyzing data;

2.2.2 Write, test, compile, maintain, update and document software code and programs that implement algorithms for reading, ingesting, reformatting, managing, processing, calibrating, and analyzing data;

2.2.3 Operate computers and run software for reading, ingesting, reformatting, managing, processing, calibrating, and analyzing data;

2.2.4 Locate and retrieve data from Earth Observing System (EOS) Distributed Active Data Information and Services Centers Archive Centers (DISC's), from National Oceanic and Atmospheric Administration (NOAA) data centers and archives, from the Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility, from the National Science Foundation's (NSF) National Center for Atmospheric Research (NCAR), from international providers of atmospheric data (e.g., European Space Agency, Japan Aerospace Exploration Agency), and other sources of atmospheric data and observations;

2.2.5 Establish databases for the effective organization, management, protection, and retrieval of data;

2.2.6 Develop, maintain, and populate Section 508 compliant websites, web servers, and ftp sites for the efficient exchange of data, data products, and non-proprietary software between GSFC scientists and their collaborators or for the open dissemination of data and data products to the science community;

2.2.7 Protect and preclude the dissemination of all proprietary data, data products, and

software and all other sensitive material associated with supported atmospheric research in accordance with NASA and GSFC requirements and regulations;

2.2.8 Process data to convert raw instrument and sensor digital signals to physical units (e.g., to convert digital counts from a radiometer to at-sensor spectral radiance)

2.2.9 Process data to derive or retrieve geophysical atmospheric parameters, variables, and characteristics (e.g., retrieve atmospheric temperature profiles from sounder data such as AIRS/AMSU and CrIS/ATMS;

2.2.10 Process data to geolocate observations and to register data and retrieved geophysical variables to latitude and longitude, cartographic projections, and other geospatial reference systems;

2.2.11 Perform appropriate statistical analyses and tests;

2.2.12 Compare data from multiple sources and at multiple scales to calibrate sensors and instruments, cross-calibrate sensors and instruments, validate parameter retrievals and data products, and validate or assess model results and predictions;

2.2.13 Document the results of data processing and analyses in reports, presentation charts, graphs, images, maps, animations, and other effective forms of data visualization;

2.2.14 Perform all computer data processing, analyses, and transfers in accordance with NASA and GSFC information technology (IT) rules, regulations, and safe practices;

2.2.15 Recommend and apply appropriate software standards and quality assurance plans for all technical software;

2.2.16 Provide support to develop algorithms and support data processing and analysis for atmospheric research areas including and not limited to:

2.2.16.1 Measuring, mapping, and tracking cloud and aerosol properties such as cloud optical thickness and effective radii, atmospheric optical thickness, water vapor, and non-precipitating cloud liquid/ice water using instruments aboard satellites (e.g., MODIS, MISR, SeaWiFS, NPP VIIRS), airborne sensors (e.g. the Cloud Physics Lidar), and ground-based sensors (e.g., Micro-Pulse Lidar Network);

2.2.16.2 Measuring the global distribution of rainfall using data from the passive microwave radiometers and active radars aboard the Global Precipitation Mission (GPM),

2.2.16.3 Measuring, mapping, and monitoring the ozone hole, total column and tropospheric column ozone, and other trace gas concentrations (e.g., sulfur dioxide, nitrogen dioxide using data from sensors such as the Ozone Monitoring Instrument (OMI), the Ozone Mapping and Profiler Suite (OMPS), and the Total Ozone and Mapping Spectrometer (TOMS).

2.2.16.4 Measuring atmospheric temperature and moisture profiles using data from the Atmospheric Infrared Sounder, the Advanced Microwave Sounding Unit and other atmospheric sounders;

2.2.16.5 Measuring the incoming spectral and total solar irradiance using data from sensors aboard the SORCE, DSCOVR, and JPSS spacecraft and future missions;

2.2.17 Produce, archive, manage, and make available atmospheric data sets including and not limited to: global monthly precipitation data sets from the Global Precipitation Climatology Project (GCPC); merged TOMS/SBUV total ozone data set; MPLNET data sets of column and vertically resolved aerosol and cloud data; TOVS Pathfinder, AIRS,

and CrIS fields of surface skin and atmospheric temperatures, atmospheric water vapor, cloud amount and cloud height; OMI and OMPS tropospheric ozone, sulfur dioxide, and nitrogen dioxide data sets; SORCE, TCTE, and TSIS total and spectral solar irradiance data sets; and Earth surface and reflectivity.

2.2.18 Analyze and inter-compare global and regional trends of atmospheric and Earth surface parameters using multi-year data from different sensors.

3.0 Documentation and Presentations

3.1 Document, catalog, and maintain libraries of the following items associated with this contract: descriptions of software developed, enhanced, or implemented; descriptions of hardware developed, modified, or operated, as well as operating manuals; manuals that describe safety procedures to be followed in the laboratories when operating equipment, when using and storing hazardous materials, and when responding to emergencies in the laboratories.

3.2 Document software necessary to manage GSFC data sets, such as the following: data sets generated by the various observations campaigns and GSFC experiments; results from the research models used in the Branches; archived data sets used in support of the research; and communications software to move data sets between computers.

3.3 Document software necessary to create or process GSFC data sets, such as the following: data sets generated by the various observations campaigns and GSFC experiments; results from the research models used in the Branches; archived data sets used in support of the research; and software to analyze or compare data sets.

3.4 Archive, document, and maintain in a user readable form of data sets used for research, development, and applications activities, whether these data originate from NASA instrument measurements, model calculations, or from external collaborators.

3.5 Provide investigator coordination, mission document preparation, database design and maintenance, and meeting support for investigators associated with field campaigns and satellite missions related to research efforts supported by this contract.

3.6 Draft reports on work performed, provide support in the preparation of presentations and drafting of articles for publication in refereed journals, provide support in the presentation of research results at scientific meetings, and in critiquing the research of others working in related fields.

3.7 Provide support for planning, organizing, providing scientific support for talks, meetings, and conferences, including: web sites, audio-visual and IT equipment, minutes and action item lists with distribution and tracking.

3.8 Provide support to aid in the preparation of GSFC reports.

3.9 Provide support for the preparation of research and development proposals submitted in response to Research Announcements of Opportunity, Broad Area Announcements, and any other research proposal solicitation open to NASA civil servants.

4.0 Mission Science Support

4.1 Provide support for project scientists and principal investigators formulate future satellite missions, particularly missions called for in "Earth Science and

Applications from Space: National Imperatives for the Next Decade and Beyond" (aka the Decadal Survey), including and not limited to: the Aerosols, Clouds, and Ecology (ACE) mission; the Geostationary Coastal and Air Pollution Events (GEO-CAPE) mission; the Active Sensing of CO2 Emissions over Nights, Days, and Seasons (ASCENDS) mission, the Global Tropospheric 3-D Wind mission; and the Global Atmospheric Composition Mission (GACM.

4.2 Provide support for project scientists and principal investigators to oversee the implementation phases of satellite missions in development such as Pre-Aerosol, Clouds, and ocean Ecosystem (PACE), Geostationary Operational Environmental Satellite R-Series Program (GOES-R), and the Joint Polar Satellite System (JPSS).

4.3 Provide support for project scientists and principal investigators to manage or oversee operations of satellite missions in orbit including and not limited to: Terra; Aqua; Aura; Geostationary Operational Environmental Satellites (GOES); and the Solar Radiation and Climate Experiment (SORCE).

4.4 Provide support for project scientists and principal investigators to formulate, plan and implement orbital and sub-orbital missions for atmospheric process studies, and validation of satellite instrumentation.

4.5 Contribute to the specification of requirements for instruments, instrument performance, satellite performance, data quality, derived data products, and ground system performance.

4.6 Contribute to the definition of mission operation concepts.

4.7 Provide support to organize and manage science teams, plan and report on science team meetings; promote and support organize sessions at symposia and special issues of scientific journals to report science team research results.

4.8 Support the pre-launch calibration and performance characterization of sensors by understanding sensor test procedures, by observing and monitoring pre-launch tests, and by analyzing test data.

4.9 Support the post-launch calibration and performance monitoring of sensors in-orbit by analyzing and evaluating calibration data, participating in field calibration experiments, updating calibration coefficients, and validating calibrated data.

4.10 Provide support in defining and specifying data products and support the development and documentation of the algorithms necessary to generate those products from satellite sensor data.

4.11 Support the specification, design, development, and operation of satellite data handling and processing systems that fall under the responsibilities of GSFC project scientists and principal investigators.

IV. Functional Requirements for GMAO Research and Development Support

The GMAO is committed to advancing data assimilation and the use of satellite data for climate analyses and for weather and climate prediction. The assimilation projects require a substantial commitment to product-oriented scientific research and development. The large and complex systems development effort requires a great deal of teamwork and a commitment to sound software engineering practices.

Each of the functional requirements described below has scientific advancement as its objective. The contractor support work required by most tasks involves the development or modification of major software systems and subsystems.

The contractor shall support projects that encompass all aspects of the GMAO research and development effort. The contractor shall provide all necessary resources including personnel, facilities, equipment, and materials, unless otherwise provided by the Government in order to meet the requirements. The Government provides local analysis and data servers and peripherals to be shared by the GMAO team, comprising civil servants, visiting scientists and contractor staff. The high-end computing resources needed to accomplish the research and development efforts of the GMAO are provided through the NASA Center for Climate Simulation (NCCS) at Goddard and through the NASA Advanced Supercomputing (NAS) Division at NASA/Ames Research Center.

In broad terms, the GMAO research and development effort consists of the following:

a. Development and use of atmosphere, ocean, and land surface data assimilation systems to enhance the utility of satellite data in environmental modeling, analysis and prediction;
b. Development and use of atmospheric constituent (aerosols and trace gases) models and assimilation systems;
c. Development and use of coupled climate models and coupled chemistry-climate models;
d. Development and use of ocean biology and carbon cycle models and assimilation systems;
e. Development and use of subseasonal-to-decadal climate forecast systems to support research into predictability and to enhance forecast skill by optimizing the use of satellite data in the initialization of the coupled forecast system;
f. Scientific analysis and visualization of model simulations, data assimilation products, and both satellite and in situ data;

The GMAO is expected to achieve, and the contractor shall support, the following specific objectives:

1. Development of advanced methods for assimilating satellite observations, focused on
   a. atmosphere (meteorology): microwave, hyperspectral infrared, and limb sounders, data in cloudy and/or raining regions, precipitation, and cloud properties;
   b. atmosphere (constituents): ozone, carbon species and aerosols;
   c. ocean: altimetry, surface salinity, and ocean color;
   d. land surface: surface temperature, soil moisture and snow;
   e. cryosphere: sea ice.

2. Development of hybrid variational-ensemble assimilation methods to ensure effective use of satellite observations.

3. Development and use of adjoint-based tools to evaluate data impact on weather prediction in the context of the entire observing system.

4. Development of coupled models, component models and data assimilation systems leading toward an Integrated Earth System Analysis (IESA).

5. Development and routine use of comprehensive diagnostic, monitoring and evaluation tools for GMAO models and assimilation systems for a variety of applications, including (a) numerical weather prediction, (b) climate analysis and prediction, (c) observing system evaluation and design of new satellite missions, (d) input to instrument team algorithms, (e) air quality prediction, and (f) other research applications that emerge from NASA research announcements.

6. Quantitative assessment and documentation of GMAO products.

7. Assembly and preparation of observations to be used in the assimilation systems.

8. Assembly of observations and outside model simulations or analyses to aid in the evaluation of GMAO models and assimilation systems.

9. Generation of quasi-operational products to support NASA instrument teams and NASA field campaigns, as well as external collaborations, and preparation of customized datasets for GMAO customers.

10. Research towards observing system design for weather, climate, and air quality applications.

11. Use of satellite observations and diagnostics from the various GMAO systems to improve the GMAO component and coupled models.

12. Development of effective techniques to initialize coupled climate forecasts and use of satellite observations to improve climate forecast skill, including the conduct and assessment of experimental climate forecasts on a regular basis.

13. Research on the underlying mechanisms and predictability of climate variations at time scales from subseasonal to decadal.

14. Production of animations using state-of-the-art visualization software and hardware, and of web-based visualization products to disseminate results from GMAO systems.

The following functional requirements shall be supported by the contractor: *(1) Atmospheric data assimilation system development and experimentation, (2) Atmospheric constituent modeling and data assimilation, (3) Land surface data assimilation, (4) Ocean data assimilation system development and experimentation, (5) Observing system simulation experiments, (6) Model development, (7) Systems integration, (8) Climate simulations, analyses and experimental forecasts, and (9) Visualization of observed and model-generated fields and the publication of scientific results.*

IV.1 ***Atmospheric data assimilation system development and experimentation***
The contractor shall be responsible for:

IV.1.1 Contributing to the atmospheric analysis development. In particular, the contractor shall contribute to tuning the DAS and the model in assimilation mode, and to improving the

formulation of forecast and observation error covariance models used within the GSI. The contractor shall also support advances to the 4D-Var implementation by developing estimates of model errors, by tuning of the 4D-Var system, and by improving the computational performance of the tangent linear and adjoint models. The contractor shall also contribute to the development of advanced methods necessary to assimilate cloud-affected observations and cloud and precipitation data.

IV.1.2 Development of advanced diagnostic tools for monitoring system performance as an integral part of the overall DAS development. The contractor shall be responsible for developing and maintaining a comprehensive suite of diagnostic tools (e.g., to examine forecast skill and fit to observations), as well as user-friendly programs and scripts to facilitate their broad use by GMAO investigators. The contractor shall be responsible for conducting appropriate diagnostic experiments and for reporting and documenting results as part of the overall development lifecycle.

IV.1.3 Ensuring all developments are optimized to run efficiently on distributed memory parallel computer architectures with large numbers of processors. System computational performance will be evaluated in the context of operational numerical weather prediction throughput requirements. Analysis development will encompass the optimization on scalable systems and the implementation of ESMF.

IV.1.4 Providing support for the GMAO Atmospheric Data Assimilation System (ADAS) in the retrieval, processing, and monitoring of conventional data streams, and of satellite data that are assimilated into the system.

IV.1.5 Providing support in terms of utilization of new satellite and conventional data, ADAS monitoring, evaluation and validation, according to requirements specified in individual task orders. Task orders may require estimating and/or reformulating error covariance models to maximize the impact of particular data types. For high-density data, such as cloud-drift winds and hyperspectral sounders, the support involves development of appropriate thinning or data/channel selection procedures.

IV.1.6 Developing and improving the capability to assimilate precipitation and cloud optical properties into the ADAS. The tasks include monitoring the data to check for biases and quality control problems, the development of appropriate error covariance models, and the conduct of experiments to evaluate the system.

IV.1.7 Conducting data sensitivity and data withholding experiments to evaluate and ensure maximum data impact in the ADAS. The requirement includes the continued development of adjoint-based tools for the ADAS to evaluate data impact in the context of the entire observing system.

IV.2 ***Atmospheric constituent modeling and data assimilation***
The contractor shall:

IV.2.1 Perform tasks to develop the ozone assimilation system further, particularly assimilation of limb sounder radiances.

IV.2.2 Evaluate the quality of ozone analyses by comparisons with independent ozone data (such as ozonesondes and products from a variety of instruments, including AIRS, MLS, OMI, GOME-2, SCIAMACHY, and MIPAS), monitor the operational ozone products, and assist users of the products as needed.

IV.2.3 Prepare the GSI for the assimilation of OMPS data from the NPP platform. Develop the assimilation infrastructure to process the real-time data stream in an operational configuration.

IV.2.4 Provide support for a variety of other stratospheric and tropospheric trace gases that shall be assimilated in addition to ozone, particularly carbon species from AIRS.

IV.2.5 Contribute to the implementation of the GMAO Global Aerosol Assimilation System (GAAS), with emphasis on MODIS aerosol measurements.

IV.2.6 Provide support on the acquisition and reformatting of input data sets, running of experiments and analysis of results.

IV.2.7 Contribute to the study of the meteorological structure and transport properties of GMAO's analysis products. Emphasis will be on the quantitative study of the three-dimensional structure of the middle atmosphere and the tropopause region, focusing on the tropical quasi-biennial oscillation, the structure of polar vortices and the surf zone, and stratosphere-troposphere exchange.

IV.2.8 Provide a quantitative assessment and documentation of the GMAO products in the middle atmosphere, develop and document suitable diagnostic packages for validation of GMAO datasets, and prepare customized datasets for GMAO customers.

IV.2.9 Contribute to the development of an Integrated Earth System Analysis by the generation and scientific analysis of aerosol and trace gas simulations and/or assimilations in conjunction with the GMAO's meteorological analyses.

IV.3 ***Land surface data assimilation***
The contractor shall be responsible for:

IV.3.1 Integrating, testing and evaluating land assimilation methods to make use of remotely-sensed observations of surface temperature, soil moisture, and snow (including MODIS land products) to analyze and predict land surface conditions and their impact on atmospheric circulation at a variety of time scales. The requirement includes the integration and evaluation of all algorithms, data assembly and preparation, model simulation, assimilation and prediction.

IV.3.2 Supporting this effort by conducting tests of the system, validating the system by diagnosing its performance in the NWP framework and in the seasonal forecast framework and by comparison with independent observations.

IV.3.3 Assembly of data sets for ingest into the assimilation system and for validation.

IV.3.4 Supporting the operational production of a near-real-time Level-4 soil moisture product for the Soil Moisture Active Passive (SMAP) mission.

IV.4 Ocean data assimilation system development and experimentation
The contractor shall be responsible for:

IV.4.1 Technical and scientific leadership in the development and exercise of a global ocean data assimilation system. Developments shall be aimed at improvements to the parallel ensemble Kalman filter assimilation and multi-variate optimal interpolation methods implemented with the GFDL MOM4 under the GEOS-5 model infrastructure and their utilization in the initialization of the coupled system.

IV.4.2 Development that focuses on assimilation of ocean altimetry, ocean surface salinity, and ocean surface color data. In situ data must include Argo. The efficacy of the developments shall be evaluated by cross-validation and by the impact on short-term climate forecast skill.

IV.4.3 Developments optimized in terms of the computational performance of the implementation on a parallel computer architecture to ensure the shortest time to solution possible. All developments must also be compliant with the Earth System Modeling Framework (ESMF).

IV.4.4 Retrieving data sets, including real-time retrievals for forecast initialization, preparing them for ingest into the assimilation system (including quality control if needed), and utilizing them for comparisons with the assimilation analyses and with the coupled forecasts.

IV.4.5 Contributing to the development of a coupled ocean-atmosphere assimilation system to support weather prediction, improved initialization of climate forecasts, and also an Integrated Earth System Analysis.

IV.5 ***Observing system simulation experiments***
The contractor shall:

IV.5.1 Provide assistance with developing, in collaboration with other GSFC and NOAA/NCEP scientists, an Observing System Simulation Experimentation infrastructure to evaluate the impact of proposed new observations and to help in planning new missions. The impact of new observations may be evaluated for environmental analyses, weather and climate prediction, and climate monitoring. The observing system tools will be extended beyond meteorological analyses to those for constituents, ocean, and land surface.

IV.6 ***Model development***
The contractor shall provide support for:

IV.6.1 Development of individual modules of the GEOS Atmospheric General Circulation Model (AGCM) and the Catchment Land Surface Model (LSM). Atmospheric model development will focus especially on the improvement of physics parameterizations in high resolution simulations, and the coupling with atmospheric chemistry modules for the troposphere and stratosphere.

Support shall include simulations conducted for model/module evaluation and validation and for scientific analyses. Support for developments in collaboration with scientists external to the GMAO will be provided as specified in individual task orders.

IV.6.2 Integration, tuning and evaluation of GEOS-5 coupled models and their next-generation implementation: the coupled atmosphere-ocean general circulation model (AOGCM) (atmosphere-ocean-land-sea-ice); the coupled chemistry-climate system; the coupled ocean biology and carbon system; and the integration of each of these into an Integrated Earth System Model.

IV.6.3 Conducting model evaluations through comparisons of output with observations. The contractor shall assemble the data sets for model validation. Particular process experiments with prescribed forcing, experiments with models of varying resolution, and the like, will be conducted. Experiments will be aimed at identifying rectifiable deficiencies in the models.

IV.6.4 Interfacing with the GMAO assimilation groups, in providing the models to be included in the analysis system and for providing feedback to the model developers on model performance issues that arise through assimilation.

IV.6.5 Component model development and assessment in a parallel computing environment through the conduct of a series of model experiments designed in collaboration with GMAO civil service staff. Model development will encompass the optimization of all components on scalable systems and the implementation of ESMF.

IV.6.6 Implementation and testing of chemistry codes coupled with the GMAO AGCM, particularly the GMI, GOCART, and GEOS-Chem models. Model simulations will be conducted to investigate relationships between the atmospheric composition and the circulation. A range of model simulations will be performed to investigate links between climate change over the past 50 years and the stratospheric ozone distribution, and tropospheric air quality changes.

IV.7 *Systems integration*
The contractor shall be responsible for:

IV.7.1 Integration of assimilation and model elements developed by GMAO scientists and collaborators within the data assimilation system into an operational configuration. The integration will encompass both algorithmic integration and optimization, and scientific integration to ensure scientific integrity and validity to support further scientific exploration and operational-quality product generation.

IV.7.2 Development of comprehensive diagnostic packages for each component and for the coupled systems, including assembly of observations and other model simulations to aid in the validation. Validation encompasses a broad range of applications – particular science applications, climate and weather prediction, instrument team applications, etc.

IV.7.3 Providing support for the online documentation of the systems.

IV.7.4 Supporting scientific validation of models, systems, and products as specified by the GMAO civil service staff.

IV.8 ***Climate simulations, analyses and experimental forecasts***
The contractor shall:

IV.8.1 Use GMAO ocean data assimilation software, land data assimilation software and the coupled model to conduct and assess experimental forecasts for subseasonal-to-decadal timescales and up to 30 years' duration. Shorter-term experiments shall be conducted in near real-time. Forecasts will also be conducted in retrospective mode, for periods defined by GMAO civil service staff, to provide for a forecast calibration. Forecast uncertainty shall be characterized through the use of ensembles.

IV.8.2 Provide assistance in the design of the ensemble strategy to most appropriately represent forecast uncertainty.

IV.8.3 Contribute to evaluation of the system. The contractor shall be responsible for regular diagnostics of forecast accuracy which will be assessed both by the amplitude and phase of the commonly used SST indices and by the patterns of SST, ocean heat content, and thermocline depth anomalies, surface wind stress anomalies over the tropical Pacific, and the surface temperature and precipitation patterns over the continental United States. Subseasonal forecasts will be evaluated as to the ability to forecast the major climate modes at subseasonal timescales, such as the Madden-Julian Oscillation, the Asian Monsoon, and the North American Monsoon.

IV.8.4 Assemble the suite of validation data, document the suite of experiments, and set up near online access to the experimental forecast output.

IV.8.5 Quantify the impact of various oceanic data streams on subseasonal to decadal climate forecasts: sea surface height from altimeters, sea surface temperature, subsurface temperature profiles from the tropical moored buoy arrays (TAO/TRITON, PIRATA, RAMA), subsurface salinity profiles from Argo, subsurface temperature from XBT data, data from drifting sensors, satellite-based surface winds, precipitation, surface salinity, etc., as specified by the GMAO civil service staff.

IV.8.6 Quantify the impact of soil moisture and snow observations on seasonal forecasts through data withholding experiments and analyses specified by GMAO civil service staff.

IV.8.7 Support testing and tuning of updated versions of the AOGCM. The contractor shall conduct simulations with the AOGCM as specified by the GMAO civil service staff, undertake diagnostics of such simulations to quantify the model's inherent variability, and compare with observations to quantify the model's verisimilitude to nature in the representation of the dominant climate modes of variability.

IV.8.8 Support scientific analyses of data and AOGCM-generated fields as well as component model-generated fields. This shall include the retrieval and maintenance of atmosphere, ocean, and

land surface observational data bases for model forcing, and for assimilation into the GMAO forecasting system as well as validation of experimental GMAO forecasts.

IV.9 ***Visualization of observed and model-generated fields and the publication of scientific results*** through the World Wide Web will be necessary on completion of experiments. The project currently uses Python, IDL, MATLAB, and GrADS for graphics and visualization. High-quality graphics are also required for presentations and for publication in the peer-reviewed literature. Publications will include presentations and web-based material for outreach to the scientific community, to agency program managers, and the general public.

V. General Functional Requirements Support

1.0 Education and Public Outreach Support

Requirements for supporting the communications of research objectives and results to the general public, to NASA management, to authorizing and appropriating committees, and for informal and formal education at all levels.

1.1 Provide support for Education and Public Outreach (E/PO) activities related to the programs and research supported under this contract. Develop, enhance, and improve E/PO programs, materials, methods, and contacts.

1.2 Transcribe verbal or written information into a cogent form for the general public, educators, and special interest researchers.

1.3 Perform outreach to convey research information in a form that is understandable to the general public, educators, and scientists.

1.4 Develop, maintain, and enhance Section 508 complaint websites to communicate and inform the general public and the scientific community about the activities of the GSFC, its Branches, and the EOS program.

1.5 Support intern and mentoring programs to help GSFC grow the next generation of Earth Scientists.

1.6 Support collaboration between the GSFC scientists and the academic community. Formal collaboration exists under the following Memoranda of Understanding and Cooperative Agreements:

- CIMSS, with the University of Wisconsin, Madison;
- ESSIC, with the University of Maryland, College Park;
- CICS, with the University of Maryland, College Park;
- GESTAR, with the Universities Space Research Association and Morgan State University, Baltimore;
- JCET, with the University of Maryland, Baltimore County;
- Cooperative agreements with Colorado State University, Fort Collins, Colorado.
- NASA Post-Doctoral Program (NPP), with Oak Ridge Associated University

1.7 Support the NSF's GLOBE primary and secondary school science education program.

1.8 Support NASA's PUMAS web site for K-12 math and science teachers.

1.9 Support NASA's educational STEM programs at Goddard that are pertinent to the atmospheric sciences, such as SCRC, SIES and SESI.

1.10 Provide support for scientific collaboration with the Howard University Program

in Atmospheric Sciences (HUPAS), particularly at the NOAA-Howard University Center for Atmospheric Sciences (NCAS) and the field observation research station at the Howard University Research site at Beltsville (HURB).

1.11 Provide support to maintain and expand working relationships between GSFC scientists with governmental (e.g., NOAA, the National Park Service, GSFC Fish and Wildlife Service, Department of Agriculture), and non-governmental organizations, for purposes of sharing content and enhancing applications. Collaborate with these groups on development E/PO materials and programs using GSFC data and/or science content.

1.12 Provide avenues, for users outside of GSFC and for scientific collaborators of GSFC members, to access programs and data located on GSFC workstations and data storage systems.

2.0 Preparation of research proposals

The contractor shall provide support for the preparation of research and development proposals submitted in response to Research Announcements of Opportunity, Broad Agency Announcements, and any other research proposal solicitation open to NASA civil servants.

3.0 Administrative Support:

Provide administrative support to the Code 610AT scientific staff.

3.1 Develop, maintain, and track database systems for all phases of administration including, but not limited to, property and chemical inventories, travel budgets, proposal charges, purchase orders, credit card purchases, property passes, proposal submissions, and reimbursable expenditures.

3.2 Assist in the preparation of the fiscal year budgets for review, gather information from funding sources, alert principal investigators to status of contracts and proposals, draft purchase requests, prepare shipping documents and arrange for pick-ups.

3.3 Prepare charts and viewgraphs for administrative reviews, provide administrative reports in accordance with contract requirements, and assist in the preparation of the fiscal year Branch budgets and their submittal to the Laboratory.

3.4 Review with the Code 610AT and ESPD leadership all administrative requirements for the fiscal year (including, but not limited to, personnel requirements, hardware and software purchases, and maintenance agreements).

3.5 Coordinate and provide logistics support for visitors from outside Goddard Space Flight Center.

3.6 Assist in planning, organizing, providing logistical support to talks, meetings, and conferences, including ESPD workshops and conferences. Provide logistical support, including: web sites, production of invitational orders for attendees, travel accommodations, meeting space set-up, break-out rooms, audio-visual and IT equipment, climate and lighting tools, copiers, faxes, phones, registration other on-site administrative assistance. Provide minutes and action item lists distribution and tracking. Make rapid travel and procurement related obligations to support workshop/project activities such as air transportation, hotel rooms, registration fees, supplies, and conference expenses. Arrange travel for non-NASA participants to include flight reservations, lodging, rental car, and other needs.