

**Contract**  
**NNG12HP06C**

## **ATTACHMENT A**

# **SCIENTIFIC SUPPORT SERVICES TO THE GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO)**

## **STATEMENT OF WORK**

**December 22, 2011**

# STATEMENT OF WORK for Global Modeling and Assimilation Office, Code 610.1

## I. INTRODUCTION

The purpose of this contract is to provide continued support to GSFC's Global Modeling and Assimilation Office (GMAO), a key activity within the Earth Sciences Division. The GMAO develops and uses comprehensive models and assimilation systems that support NASA's Earth science research enterprise and contribute to the nation's capabilities in climate, weather and atmospheric composition prediction.

## II. BACKGROUND

The Global Modeling and Assimilation Office at Goddard develops, operates, and maintains data assimilation systems for the atmosphere, ocean, land surface, atmospheric constituents, and ocean biology. The data assimilation systems comprise observation characterization for the assimilation context, the analysis systems which combine model and observation information, and the models required to interface with the analysis systems. The GMAO also develops 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 the external science community in developing and validating these 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 being developed or implemented using the Earth System Modeling Framework (ESMF).

The GMAO atmospheric data assimilation system (also referred to herein as the GEOS DAS) assimilates data from selected EOS instruments as a path to transition these observations to operational systems, provides assimilated data products to EOS instrument teams for use in their retrieval algorithms, and generates products in support of international projects and NASA field campaigns. Synthesis products that reprocess historical data streams during the satellite era are focused on the climate record and are openly available online through the Goddard Earth Sciences Data and Information Services Center (GES DISC). Products that support international projects (such as the Year of Tropical Convection) and field campaigns are available through the data portal of the NASA Center for Climate Simulation. Model simulations are also generated for scientific analysis and are available for collaborating scientists. A description of the current production system is available at the GMAO web site:

<http://gmao.gsfc.nasa.gov/products>. The GEOS-5 DAS includes the Gridpoint Statistical Interpolation (GSI) scheme initially developed at NOAA/NCEP and now developed jointly by NCEP and GMAO. GEOS-5 consists of over one million lines of FORTRAN code.

The DAS assimilates conventional meteorological data, satellite radiance data from atmospheric sounders, temperature retrievals from limb sounders, remotely sensed precipitation, satellite-retrieved ozone, and satellite-derived winds. The GMAO is also advancing assimilation for new sensors and platforms; working towards the assimilation of cloud-affected radiances; optimizing the selection of data from existing instruments; and developing capabilities for assimilation of trace gases, carbon species and aerosols.

In addition to tuning the current GEOS-5 model and DAS, the GMAO is undertaking developments for the next-generation system. As part of this development pathway, a four-dimensional variational (4D-Var) assimilation implementation, which will be the sixth version of the GEOS DAS (GEOS-6 DAS), is being tuned and tested, and a hybrid approach that includes ensembles is in the early stages of development. This version is expected to provide improved products, especially through better temporal treatment of the satellite data and better modeling of the background error covariances.

The GMAO develops modeling and assimilation systems for an experimental short-term climate prediction capability, on time scales from subseasonal to decadal, for NASA's Science Mission Directorate. The systems are used to help assess the role of satellite data as part of a global Earth observing system by investigating the optimal blend of remote and in situ observations for short-term climate prediction and to assess the predictability of decadal climate signals. The coupled atmosphere-ocean-land-ice modeling system and the component models being used by the GMAO are presented at <http://gmao.gsfc.nasa.gov/systems/geos5/>. The initialization of the coupled system focuses on initialization of the ocean and land surface components within the coupled model for consistency between all components. Multivariate Optimal Interpolation and Ensemble Kalman Filter methods have been developed for the ocean component (see <http://gmao.gsfc.nasa.gov/research/oceanassim/>), the latter being key for the assimilation of satellite altimetry. Ensemble Kalman Filter methods have been developed for the assimilation of soil moisture and snow observations into the GMAO Catchment land surface model (<http://gmao.gsfc.nasa.gov/research/landsurface/>). For subseasonal and seasonal-to-interannual prediction, the project targets not only the short-term climate variations associated with SST variations in the tropical Pacific, but also those processes and teleconnections that have socio-economic impacts on the continents, especially the United States. For longer time scales, ocean processes outside the equatorial waveguide are important and so the ocean assimilation and coupled model initialization considers the entire globe. The ocean assimilation system is used to estimate and document the state of the ocean climate ([http://gmao.gsfc.nasa.gov/cgi-bin/ocean/OCEAN\\_CLIMATE/](http://gmao.gsfc.nasa.gov/cgi-bin/ocean/OCEAN_CLIMATE/)).

In addition to the development of its experimental prediction systems, GMAO currently conducts research in the area of subseasonal-to-decadal variability of Earth's climate system, with specific emphasis on variability due to the El Nino-Southern Oscillation (ENSO), monsoon phenomena and the identification of mechanisms controlling long-term drought. These studies use simulations of the coupled atmosphere-ocean-land system as well as their component models for process studies, for assessment/validation

of the models, for investigations of short-term climate predictability, and for attribution of climate and weather extremes. Such studies help identify areas in which further model development is needed. Analyses of satellite and in situ observations of the ocean, atmosphere and land surface characteristics are also undertaken. Such studies, and the experimental predictions themselves, require the assembly, quality control, and organization of various data streams.

It is expected that GMAO support will require experience in theoretical and observational oceanography, atmospheric dynamics, physics and chemistry, land surface processes, numerical analysis, ocean and atmospheric model development, assimilation methods for the atmosphere, ocean and land surface, statistical analyses, data format protocols, local data system software design and management, visualization software development, software development for high end computing, software engineering, and education and outreach.

### **III. GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO) GENERAL OBJECTIVES/REQUIREMENTS**

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 commitment to sound software engineering and project management.

Each of the 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 within the GMAO that encompass all aspects of the development, operation, and maintenance of the assimilation and forecast systems, specifically in three areas: Scientific Research and Development Support, Development and Maintenance of Operational Capabilities, and Project Management Support. 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 at Goddard and through the NASA Advanced Supercomputing (NAS) Division at NASA/Ames Research Center.

### **PROJECT OBJECTIVES**

- 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 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 of model simulations, data assimilation products, and both satellite and in situ data;
- g. Visualization of satellite data, model simulations, and data assimilation products and preparation of relevant materials for research proposals and for outreach to the scientific community, agency program managers, and the general public;
- h. Generation of products on an operational basis to support NASA instrument teams, other customers and GMAO research.

Specific tasks are expected to include those described below.

## **IV. Scientific Research and Development Support**

### **A. SPECIFIC OBJECTIVES OF THE PROJECT**

The GMAO project is expected to achieve, and the contractor shall support, the following 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.
2. Development of 4D-Var assimilation methods using the atmospheric forecast model as a weak constraint to ensure effective use of satellite observations and using ensembles to provide estimates of the background error covariances.
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 comprehensive diagnostic, monitoring and evaluation tools for the GMAO models and analysis systems for a variety of applications, including (1) numerical

weather prediction, (2) climate analysis and prediction, (3) observing system evaluation and design of new missions, (4) input to instrument team algorithms, (5) air quality prediction, and (6) other research applications that emerge from NASA research announcements.

5. Quantitative assessment and documentation of GMAO products.
6. Assembly and preparation of observations to be used in the assimilation systems.
7. Assembly of observations and other model simulations or analyses to aid in the evaluation of GMAO models and assimilation systems.
8. 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.
9. Research towards observing system design for weather, climate, and air quality applications.
10. Use of satellite observations and diagnostics from the various GMAO systems to improve the GMAO component and coupled models.
11. 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.
12. Research on the underlying mechanisms and predictability of climate variations at time scales from subseasonal to decadal.
13. Production of animations using state-of-the-art visualization software and hardware, and of web-based visualization products to disseminate results from GMAO systems.
14. Generation of materials, including presentations and web pages, documenting GMAO results for the scientific community, agency program managers, and the general public.

## **B. REQUIREMENTS**

The following 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*, (9) *Visualization of observed and model-generated fields and the publication of scientific results*, and (10) *Preparation of research proposals*.

## **B.1 Atmospheric data assimilation system development and experimentation**

The contractor shall be responsible for:

**B.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.

**B.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.

**B.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.

**B.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.

**B.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.

**B.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.

**B.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.

## ***B.2 Atmospheric constituent modeling and data assimilation***

The contractor shall:

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

B.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.

B.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.

B.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.

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

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

B.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.

B.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.

B.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.

## ***B.3 Land surface data assimilation***

The contractor shall be responsible for:

B.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.

B.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.

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

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

***B.4 Ocean data assimilation system development and experimentation***

The contractor shall be responsible for:

B.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.

B.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.

B.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).

B.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.

B.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.

***B.5 Observing system simulation experiments***

The contractor shall:

B.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.

### ***B.6 Model development***

The contractor shall provide support for:

B.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.

B.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 Earth System Model.

B.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.

B.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.

B.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.

B.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.

### ***B.7 Systems integration***

The contractor shall be responsible for:

B.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.

B.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.

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

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

**B.8 *Climate simulations, analyses and experimental forecasts***

The contractor shall:

B.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 the period defined by GMAO civil service staff, to provide for a forecast calibration. Forecast uncertainty shall be characterized through the use of ensembles.

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

B.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 U.S. 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.

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

B.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.

B.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.

B.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.

B.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.

***B.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.

***B.10 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.

## **V. Development and Maintenance of Operational Capabilities**

### **A. SPECIFIC OBJECTIVES OF THE PROJECT**

1. GMAO operational system development and maintenance;
2. Data Assimilation System (DAS) data production operation.
3. Liaise between GMAO and NASA computing centers to define and meet GMAO's production requirements.

### **B. REQUIREMENTS**

## **B.1 GMAO operational system development and maintenance**

The contractor shall be responsible for:

- B.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.
- B.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.
- B.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.
- B.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.
- B.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.
- B.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.
- B.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.
- B.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.

### **B.2 *Data assimilation system (DAS) data production operation***

The contractor shall:

B.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.

B.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.

B.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.

B.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.

B.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.

### **B3. NCCS-GMAO Liaison**

The contractor shall:

B.3.1 Act as an interface between GMAO (management and lead software system developers) and NASA computing center (NCCS and NAS) staff regarding GMAO's computer resource requirements to meet throughput and product distribution requirements for high-priority GMAO production systems.

B.3.2. Derive computer system and job scheduling configurations to meet performance (throughput and product access) requirements. Undertake risk assessments for the NCCS based on available computer resources and scientific program performance.

B.3.3 Undertake overall computer hardware and software system requirements analyses for NCCS and recommend system solutions.

## **VI. Project Management Support**

### **A. SPECIFIC OBJECTIVES OF THE PROJECT**

1. Provide project administration support to the GMAO;
2. Collaborate with GMAO science staff to develop informative web pages.

### **B. REQUIREMENTS**

#### ***B.1 Project administration support***

The contractor shall:

B.1.1 Provide GMAO procurement support to include: generating and tracking orders, and communication with vendors, customers, and local systems staff.

B.1.2 Provide support to the GMAO in maintaining documentation, files and office records; maintaining office supplies; producing and distributing deliverable reports; coordinating meetings, seminars, and travel for civil service, technical staff and visitors; communicating general information to technical staff; and ensuring that web-based information on GMAO organizational issues and structures are current.

#### ***B.2 GMAO web site management***

The contractor shall:

B.2.1 Provide technical support to maintain the GMAO web pages, the GMAO internal web pages known as the GMAO Intranet, and the GMAO external collaboration pages known as the GMAO Extranet.

B.2.2 Maintain the GMAO web policy and standards in accordance with the GSFC and Sciences and Exploration Directorate web policies and standards. Provide technical assistance to GMAO web authors to ensure appropriate changes in format, organization, and content are made to comply with GSFC and Sciences and Exploration Directorate web policies and standards. Develop web templates to maintain consistency and support standardization.

B.2.3 Provide web development support to initiate new pages for GMAO staff, as requested. The contractor shall assess the relevance of web material periodically and coordinate with GMAO web authors to update obsolete information and to add/delete information.

B.2.4 Work with GMAO science staff to develop informative web pages summarizing the GMAO science investigations and exciting results, including development of material for outreach to the general public.

B.2.5 Keep abreast of the latest web technology and make recommendations to improve the performance and usability of the GMAO web and Intranet pages, as needed.

**B.2.6 Maintain online databases and information services, particularly:**

- The GMAO Monitoring System (GMS)
- Internet-based access to selected GMAO datasets
- On-line databases of GMAO documents and publications
- On-line databases of GMAO products
- On-line description of internal GMAO procedures
- On-line documentation of software and of system performance.