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600 DIRECTOR OF SCIENCES AND EXPLORATION

Plans, organizes, implements, and evaluates a broad program of scientific research, both theoretical and experimental, in the study of the Earth-Sun system, the solar system and the origins of life, and the birth and evolution of the universe. The program ranges from modeling and basic research, to flight experiment development, and to data analysis and communication of results.

603 ADMINISTRATION AND RESOURCES MANAGEMENT OFFICE

Responsible for administration and management of SED resources in support of the Directorate's technical program. Primary financial and business management functions include coordination and administration of budget planning and execution to support the programmatic and institutional requirements of the Directorate's Divisions and Offices, and the associated flight instruments, mission operations and data analysis projects, and supporting research and technology programs. Major responsibility also includes resource monitoring, analysis, and administrative reporting supporting the Directorate's overall resources. The Office is responsible for implementation of all NASA/GSFC policies and procedures to ensure proper financial and business management within SED, as well as on-going coordination and review to assess compliance. Trains and provides collocated resources support to Divisions and Offices with within the Directorate to support efficient implementation of resources and to ensure effective utilization of resources.

605 SCIENCE PROPOSAL SUPPORT OFFICE

The Science Proposal Support Office administers the SED Directorate new business process and provides assistance to the Directorate's scientists in writing winning proposals. This includes: 1) coordinating the call for concepts, peer reviews and presentations to the Director of SED for new mission and instrument proposals; 2) supporting scientist proposals for small research activities and ensuring that they are able to write winning proposals; 3) tracking the Directorate's success rate and providing feedback to the Directorate management on winning strategies; and 4) alerting the Directorate scientists to new business opportunities. The Office coordinates with the Assistant Director for Technology and Associate Director for Science Engineering to strategically manage technology development resources consistent with Directorate science, mission, and instrument proposal priorities. The Science Proposal Support works with the Center's New Opportunities Office on all SED activities associated with the Center's overall new business process.

606 COMPUTATIONAL & INFORMATION SCIENCES & TECHNOLOGY OFFICE

The Computational & Information Sciences and Technology Office (CISTO) provides applied information system research and services to support the research programs of the Science and Exploration Directorate. The office supports high performance computing, provides high rate network and information technology (IT) security services, and performs research in information science and technology, and provides scientific visualization services. The Office supports the Center Chief Information Officer in development of strategic IT plans, policies, and procedures for computing resources and security; and leads Directorate efforts to implement policies and ensure compliance. The Office develops strategies to optimize cost-effectiveness in the utilization of information technologies in support of the Directorate's mission.

606.1 NETWORKS AND SECURITY GROUP

Provides strategic network planning, services, and capabilities to efficiently meet overall Directorate research and mission requirements. Leads implementation of network security procedures and functions to protect Directorate systems and data from intrusions, and assures that Agency and Center security requirements are met. The organization works with the CIO's Office and other Center organizations to develop integrated design and management of IT networks. Designs and deploys specific capabilities necessary to support Directorate projects. Manages the Agency-level NASA Incident Response Center (NASIRC).

606.2 HIGH PERFORMANCE COMPUTING GROUP

Provides strategic planning, design, and procurement of project-specific and shared-resource high performance computational resources and services. Provides portal services to leadership class systems external to Goddard, and provides the IT infrastructure needed to support the analysis environment for modeling and assimilation activities. Supports discipline-specific software integration activities in other Directorate organizations to assist in the transition to high performance computing architectures.

606.3 INFORMATION SCIENCE & TECHNOLOGY RESEARCH GROUP

Performs strategic technology planning to prioritize technology advances needed to enable science investigations and missions. Conceives, proposes, and implements applied information science and technology research projects needed to achieve Directorate science research objectives. Provides expertise in computing and information science and technology as a service for the Directorate. Explores new challenges in computing and

information science and technology research that are relevant to the Directorate, and facilitates new uses of Directorate science and data products.

606.4 SCIENTIFIC VISUALIZATION STUDIO GROUP

Facilitates scientific inquiry and outreach within NASA programs through visualization. The SVS collaborates with scientists to create visualization products, systems, and processes to promote a greater understanding of Earth and Space Science research activities at Goddard Space Flight Center and within the NASA research community. All SVS visualizations are available through their website.

610 EARTH SCIENCES DIVISION

The Earth Sciences Division conducts a comprehensive research and technology development program that is dedicated to advancing our knowledge of Earth's weather, climate, and systems of life. These activities extend across the atmospheric sciences, and the hydrospheric and biospheric sciences. The research includes studies of Earth's climate, and of the complex interrelations between the various Earth systems and the existence of life on Earth. The scope of ESD activities ranges from basic research; to the definition, development, and implementation of spaceflight missions and instruments; and to the analysis and dissemination of data to meet national needs. Also included are major data interpretation and dissemination activities that archive and provide NASA data for application to national priorities.

610.1 GLOBAL MODELING AND ASSIMILATION OFFICE

The Global Modeling and Assimilation Office (GMAO) focuses on comprehensive global climate modeling and on satellite data synthesis through data assimilation. Global ocean, atmosphere, and land surface models are developed as components of data assimilation and forecast systems as well as for addressing the weather and climate research questions identified in NASA’s science mission. The Office promotes the use of satellite data by operational agencies through the transition of targeted assimilation technology. It uses assimilation tools to contribute to the design of future missions. It enables the use of satellite data by the research community and by NASA’s Instrument Teams and field campaigns through the provision of research-quality assimilated data products, including meteorology, trace gas, aerosol and climate products, and ocean and land surface products. GMAO research focuses on observing system science, on understanding transient climate variability and its predictability, on the hydrological cycle, and on the interaction between the biospheric and chemical components of the Earth system and climate.

610.2 GLOBAL CHANGE DATA CENTER

The Global Change Data Center (GCDC) Office builds and operates data and information systems in support of Earth science missions and science research. The GCDC leads the formulation and implementation of initiatives to increase end-to-end data management and utilization efficiency.
In performing these functions, members of the Office:

- Apply operationally proven data systems components to support ongoing missions (data acquisition, processing, archive, distribution, search/access).
- Work closely with science teams to support data production and validation (algorithm development/integration, data calibration/validation, research products, discipline-oriented services).
- Develop value-added services to facilitate utilization of Earth Science Enterprise (ESE) data and information (data mining, multi-mission products, visualization/analysis, applications and near-real-time products, provenance, quality assessment).
- Apply engineering and science expertise to reuse systems in support of new missions and data (project management, system design, development/reuse, operations, and sustaining engineering).
- Carry out research in the development and application of new technology (commodity hardware computing and storage platforms, virtualization and federated data services, and common interfaces and protocols for data and services interchange).

Mission and models supported include:

- Atmospheric Composition: AURA (HIRDLS, MLS, OMI), LIMS, SORCE, TOMS, TOVS, UARS, ACOS, and OCO-2.
- Atmospheric Dynamics: AQUA (AIRS), MSU
- Ocean Color: CZCS/Nimbus-7, MODIS, OCTS/ADEOS-1, SeaWiFS, Aquarius, NPP PEATE
- Modeling: GEOS, MERRA, GDAS, LDAS
- Precipitation: TRMM (PR, TMI, VIRS) and GPM

In addition to the science data system support described above, GCDC staff provides information technology, project management, policy, and programmatic support to other organizations in the Earth Sciences Division and the Sciences and Exploration Directorate.

610.3 SOFTWARE SYSTEMS SUPPORT OFFICE

The Software Systems Support Office (SSSO) is a program-provided activity to support NASA modeling programs. The activities include development of software environments

to support collaborative research amongst a range of NASA modeling and assimilation activities. The environment will support, for example, interoperability, reuse, ease of use, and performance portability addressing the specific requirements of high-end modeling and assimilation. SSSO will promote the adoption of modern software engineering principles into the science. SSSO will supply human resources to NASA-funded science teams in specific programs, for example the Modeling, Analysis, and Prediction Program, to assure compliance with the Earth System Modeling Framework (ESMF) and to integrate, in partnership with members of the science team, developments, and modifications into the program models. Scientific validation will be the responsibility of SSSO's science partners.

The computational mission of SSSO will focus on high-performance computing. This will include the development of scalable parallel software for distributed and shared memory environments. In addition, SSSO will work to develop analysis capabilities, for example visualization and data mining, suitable for high data volume modeling and assimilation activities. The computational facilities will be distributed across the nation, and analysis will require information from these facilities as well as distributed observational data systems. SSSO will represent the computational requirements of specified NASA-sponsored modeling and assimilation for computational systems design and procurement.

SSSO will support the NASA Headquarters Modeling, Analysis, and Prediction (MAP) program office by providing software, data, and web services. This includes managing access into and out software repositories. SSSO will direct MAP inquiries to appropriate science partners.

SSSO will require formal teaming with both modeling science teams within NASA as well as at various agencies and academic institutions. Formal teaming will also be required with NASA's high performance computing organizations, the NASA Center for Climate Simulations (NCCS) and NASA Advanced Supercomputing (NAS).

610.4 OFFICE OF APPLIED SCIENCES

The Office of Applied Sciences is responsible for identifying potential applications of Earth science discoveries, scientific observations, data analyses, modeling, and technology that could benefit other government and international agencies, industry, and the public. The Office works with Division scientists to identify scientific activities that may have potential use, and with external organizations to explore need, feasibility, and benefits. Where potential applications exist, the Office works with Division scientists and engineers and with the potential users to prototype and demonstrates the concept, evaluate the results, and support the transfer to operational use.

610.W FIELD SUPPORT OFFICE

The Field Support Office is located at the Wallops Flight Facility in Wallops Island, VA, and is a focal point for field research activities that support the larger Earth Sciences Division program. This includes field programs that are conducted at the Wallops Flight Facility and at the ESD laboratories at Greenbelt, as well as field campaigns using the instrumentation, platforms, or resources available at the Facility. This includes activities such as:

- Conceiving, building, testing, and operating active and passive remote sensing and in situ instruments for Earth and space sciences research from ground, aircraft, balloon and satellite platforms, particularly related to the Global Precipitation Measuring mission;
- Participating in the full complement of scientific research activities including measurements, retrievals, data analysis, model simulations, and the calibration and validation of measurements from NASA sensors;
- Collaborating with other scientists and engineers from the Greenbelt campus and other NASA centers, universities and national and international government agencies.

611 GODDARD INSTITUTE FOR SPACE STUDIES

The Goddard Institute for Space Studies (GISS) conducts a comprehensive theoretical and experimental research program focused on the causes of long-term climate change. The program includes remote sensing of the Earth and planets, modeling activities to understand the factors influencing long-term climate change, and basic studies of how the Earth, the sun, and life have evolved together and continue to co-exist. GISS places an emphasis on involving students and educators in its research and measurements, and aims to foster public understanding of its research and the science research process.

612 MESOSCALE ATMOSPHERIC PROCESSES LABORATORY

The mission of the Mesoscale Atmospheric Processes Laboratory is to understand the physics and dynamics of atmospheric processes through the use of satellite, airborne and surface-based remote sensing observations, and computer-based simulations. Development of advanced remote sensing instrumentation (primarily lidar) and techniques to measure meteorological parameters in the troposphere is an important focus. Key areas of investigation are cloud and precipitation systems and their environments, including aerosols, from the scale of individual clouds and thunderstorms through mesoscale convective systems and cyclonic storms, and up to the scale of the impact of these systems on regional and global climate. The processes constituting the interaction of the atmosphere with the land and ocean surface beneath it are also of high priority. Thus, the Laboratory focuses its research on all aspects of the atmospheric hydrologic cycle, its

connections to the global energy cycle, and associated hazards. The Laboratory also seeks to contribute to formulation of mission concepts to support planetary exploration, both measurements and modeling concerned with assessment of meteorological hazards.

613 CLIMATE AND RADIATION LABORATORY

The Climate and Radiation Laboratory has a three-fold mission: (1) to understand, assess, and predict climate variability and change, including the impact of natural forcings and human activities on climate now and in the future, (2) to assess the impacts of climate variability and change on society, and (3) to consider strategies for adapting to and mitigating climate variability and change. To address this mission, a wide scale range is studied, from the microscale to the Earth-Sun distance in space, and from microsecond to geologic in time. Research focus areas include tropospheric aerosols, cloud processes, rainfall, water vapor, winds, solar radiation, and surface properties. Key disciplines are radiative transfer, as a driver for climate change, and as a tool for the remote sensing of parameters of the Earth's climate system, climate theory and modeling over the full range of scales, and the development of new methods for the analysis of climate data. Ongoing projects in cooperation with NASA partners address gaps in the current climate observing system, development, and deployment of new instruments, and planning for future space-based and in situ missions.

614 ATMOSPHERIC CHEMISTRY AND DYNAMICS LABORATORY

The Atmospheric Chemistry and Dynamics Laboratory conducts research on remote sensing of aerosols and atmospheric trace gases from satellite, aircraft and ground, and develops computer-based models to understand and predict the long-term evolution of the ozone layer and changes in global air quality caused by human activity. Studies the interaction between atmospheric chemistry and climate change are emphasized. The Laboratory develops, maintains, and reprocesses research quality long-term ozone data to enable national and international ozone research and assessment. It continues its long history of providing science leadership for NASA’s atmospheric chemistry satellites, such as TOMS, UARS and EOS Aura, and develops concepts for future satellite missions.

615 CRYOSPHERIC SCIENCES LABORATORY

The Cryospheric Sciences Laboratory provides national leadership in understanding the role of ice and snow in the global Earth System. Scientists within the Laboratory analyze data and develop remote sensing methods, algorithms, and physical models to address several important questions:

- What is the current state of the cryosphere and how is it changing?
- What are the mechanisms that control those changes?

- How do these changes impact the rest of the Earth System?

Sea ice research efforts focus on understanding the variability of ice cover over time, how the sea ice modulates the exchange of energy and moisture between the ocean and atmosphere, and the influences of sea ice on ocean circulation. Studies of glaciers and ice sheets are targeted toward understanding where these ice masses are growing or shrinking and why, how ice sheet melting contributes to sea level rise, and how global ice interacts with the climate system either in response to, or as indicators of climate change. Snow research within the Laboratory is concerned with the role of seasonal snow cover and snowpack accumulation and ablation in the climate system and its influence on the Earth's energy balance and water budgets. To carry out these important activities, the Laboratory combines comprehensive in situ, aircraft, and satellite observations along with sophisticated modeling efforts to characterize the behavior of snow and ice and understand the processes at work. The Laboratory provides the scientific expertise needed to develop necessary instrumentation and satellite missions, develop research-quality data sets to address these questions, and work with the broader research community to ensure effective utilization of these tools and capabilities. Additionally, the Laboratory applies knowledge and expertise in cryospheric remote sensing and the physics of ice to explore cryospheric processes on other bodies in the solar system, such as Mars and Europa.

616 OCEAN ECOLOGY LABORATORY

The goal of the Ocean Ecology Laboratory is to be a focal point for novel research and development of remote sensing instruments and products for research in ocean ecological processes. This includes activities such as:

- Conceiving and operating ocean color and other ocean biology instruments from ground and satellite platforms;
- Participating in full complement of scientific research activities including measurements, retrievals, data analysis, model simulations, and calibration/validation;
- Collaborating with other scientists and engineers from GSFC and other NASA centers, universities and national and international government agencies.

617 HYDROLOGICAL SCIENCES LABORATORY

The Hydrological Sciences Laboratory conceives of and executes observationally-driven research to enable improved quantification, understanding, and prediction of the waters of the Earth, including their occurrence, circulation, and distribution, chemical, physical, biological and thermodynamic properties, reaction with the environment, resource management, and response to Earth System variability and change. These research activities emphasize the development of remote sensing physical principles to observe and model global hydrologic cycle storage components such as lakes, streams, rivers,

groundwater, seasonal snow pack and soil moisture, and the hydrologic fluxes, such as precipitation, evapotranspiration, river discharge, and associated energy budgets. The Laboratory leads and enables community hydrologic research to address real-world water issues using NASA's unique view from space through developing innovative remote-sensing theory, field-studies, models, and data assimilation methods. Enable cross-discipline research advancements such as working with meteorologists to enhance weather and climate prediction systems, engineers to develop new sensors and missions, and water managers to improve decision support. The Laboratory applies terrestrial water science and remote sensing expertise to support the exploration and possible long-term inhabitation of the Moon and Mars.

618 BIOSPHERIC SCIENCES LABORATORY

The Biospheric Sciences Laboratory conducts fundamental and applied research on the carbon cycle, ecosystem dynamics, and land cover change, emphasizing the use of remote sensing techniques. The Laboratory's research goals are primarily aligned with the following NASA science questions:

- How are global ecosystems changing?
- What changes are occurring in global land cover and land use, and what are their causes?
- How do ecosystems, land cover, and biogeochemical cycles respond to and affect global environmental change?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?
- How will carbon cycle dynamics and terrestrial and marine ecosystems change in the future?

In pursuit of answers for these questions studies are made of the state, variability, and prediction of ecological systems ranging from small-scale forest disturbance and alterations to the urban environment, to regional agricultural crop productivity and desertification processes, to global vegetated ecosystems. Study techniques include biophysical on-site measurements; aircraft overflights; analysis of satellite data from NASA, NOAA, and international missions; and theoretical modeling. In addition, research is conducted in support of new and existing NASA missions including sensor characterization and calibration, atmospheric correction for sensor data and advanced information extraction techniques. Laboratory scientists have key roles in enabling NASA missions as project and mission scientists (e.g., Landsat, Landsat Data Continuity Mission, Earth Observer -1, Terra, and NPOESS Preparatory Program) and in large-scale interdisciplinary projects (e.g., FIFE, BOREAS, LBA, SAFARI, and NACP.) The

Laboratory also collaborates with research groups in and outside of NASA to exploit new sensing technologies and data systems. Laboratory expertise in the use of remote sensing technology including radar, lidar, multiangle, and hyperspectral techniques for surface characterization can be applied to NASA's new Exploration initiative.

619 TERRESTRIAL INFORMATION SYSTEMS LABORATORY

The Terrestrial Information Systems Laboratory supports the requirements of GSFC projects that advance our understanding of the atmosphere, hydrosphere, and biosphere on a global scale through the production of stable, well calibrated, and scientifically validated products from a series of Earth observing satellites. In producing quality data products, members of the Laboratory are engaged in:

- Developing algorithms for precisely locating and atmospherically correcting observations from satellite instruments;
- Developing and operating computing systems that produce, archive, and distribute global products;
- Assessing the quality of global products as they are produced;
- Implementing measurement systems for science disciplines to inter-relate observations from multiple instruments over long time scales to support investigations into climate and ecosystem change;
- Developing and managing a global network of validation sites and;
- Innovative research in the areas of computational algorithms, computing systems, and technologies for acquiring, archiving, searching, and distributing remotely sensed data.

Recognizing the need for a rapid response in many of NASA application areas, the Laboratory also partners with other federal agencies, such as the Department of Interior and Department of Defense, to develop and operate computing systems which provide custom products in near real-time to national and international users for applied research activities (such as fire and flood monitoring, famine prediction, invasive species, and ecological forecasting) and applications, e.g. military tactical support.

660 ASTROPHYSICS SCIENCE DIVISION

The Astrophysics Science Division provides scientific leadership to achieve NASA's strategic science goals in the exploration of the Universe by addressing the following questions:

- How do galaxies, stars and planetary systems form and evolve?
- What is the diversity of worlds beyond our solar system?
- Which planets might harbor life?

- What powered the big bang?
- What is the nature of the mysterious Dark Energy that is pulling the universe apart?
- What happens to space, time and matter at the edge of the black hole?
- What are the cycle of matter and energy in the evolving universe?

To do this, the Division provides project scientists to ensure the science requirements of the GSFC missions are met, and also conducts a broad program of research in the realm of astronomy, astrophysics and fundamental physics. This research is the study, by way of photons, particles, and gravitational waves, of processes in cosmic sites and the physics processes operating therein. These involve complimentary studies using sub-millimeter, infra-red, optical, ultra-violet, x-rays, gamma rays, gravitational waves, and energetic charged particles. The Division scientists develop theoretical models of the origin and structure of astrophysical objects and processes, design experimental approaches and hardware to test these theories, and interpret and evaluate data gathered from the experiments, archive and disseminate the data, provide expert user support to the community, publishes conclusions, and undertakes education and public outreach programs centered on the Division's science missions.

660.1 HIGH ENERGY ASTROPHYSICS SCIENCE ARCHIVE RESEARCH CENTER

The High Energy Astrophysics Science Archive Research Center (HEASARC) is the primary NASA archive for high-energy astronomy missions, in extreme ultraviolet, X-ray and gamma-ray wavelengths. The HEASARC provides archival data, multi-mission software and analysis tools, information about current and past observatory missions, and science and mission operations. The HEASARC supports the use, by the broadest possible community, of astrophysics data through guest observer programs, data analysis software, instrument calibration, multi-mission standards, and archive access. The HEASARC is responsible for dedicated science support facilities for individual missions. The HEASARC is also responsible for administering the guest observer programs for current astrophysics missions. The HEASARC personnel design, develop, and implement the computer programming required for the processing and analysis of astrophysical data. The HEASARC supervises and performs the production processing of all data through the final analysis phases. The HEASARC develops requirements for and monitors performance of all contracts for programming and data processing support services.

660.2 OFFICE OF SCIENTIFIC COMPUTING

The Office of Scientific Computing oversees the computing requirements for scientific data processing and analysis functions for the Division. Personnel in the office assess the computing hardware and software required to carry out scientific research in a productive manner. Astronomical application software is installed and maintained on user's desktops and servers. The office personnel design, develop, and implement the computer

programming required for the processing and analysis of astrophysical data. It manages all aspects of the Division's computer processing and serves as the focal point for all computer related matters including Information Technology Security. The office develops requirements for and monitors performance of all contracts for programming and data processing support services.

660.3 INSTRUMENT DEVELOPMENT GROUP

Designs, develops, and assesses the scientific quality of advanced, high performance instrumentation from sub-mm to gamma-ray, cosmic rays and gravitational waves. The instrumentation is flown on satellites, rockets, balloons, aircraft, and is tested in ground-based applications. Provides for the development and operation of laboratory equipment needed for instrument development and calibration. Provides design, development, and test for advanced detector, electronic and optical-mechanical instrumentation in support of scientists in the laboratory. The group develops requirements for and monitors performance of all contracts for electrical, mechanical and technician engineering support services.

661 ASTROPARTICLE PHYSICS LABORATORY

Conducts research at the interface between cosmology and high-energy particle physics to investigate the birth and evolution of the Universe in terms of unified theories of fundamental interactions. This includes a broad range of space based scientific investigations to study the origin, nature, and effect of cosmic rays, and the electromagnetic radiation that carries the signatures of nuclear, thermal, dark matter, and acceleration processes through out the Universe. Support the Solar System Exploration Division by providing Gamma ray detectors to characterize the surface composition of solar bodies. Support the Sun-Earth Exploration Division by providing Cosmic ray detectors to determine the energy and composition of the solar wind.

662 X-RAY ASTROPHYSICS LABORATORY

Conducts astrophysical investigations of a broad range of systems from remote robotic observations of nearby solar system objects, to cosmological structures utilizing the radiation that they produce, primarily using X-ray radiation. This includes the physics of extreme environments, such as those near the event horizons of black holes, and on the evolution of stars, galaxies, and large scale structure. Support the Sun Earth Exploration Division by providing detectors to characterize the surface composition of solar system bodies. Supports the Solar System Exploration Division by providing remote observations of solar system bodies.

663 GRAVITATIONAL ASTROPHYSICS LABORATORY

Conducts a broad range of scientific investigations to test Einstein's theory of General Relativity. Provides the science and technical leadership towards the development of space based gravitational wave detection systems.

665 OBSERVATIONAL COSMOLOGY LABORATORY

Use the scientific method to understand the origin, evolution and ultimate fate of the Universe, including: 1) what powered the big bang, 2) the size, shape, and matter-energy content of the Universe, 3) when the first stars and galaxies appeared and their evolution with Cosmic Time, and 4) the nature of the mysterious dark energy that is driving the universe apart.

667 EXO-PLANETS AND STELLAR ASTROPHYSICS LABORATORY

Conduct remote science investigations and observations to determine how, when and where planetary systems form and evolve, characterize extra-solar planets and identify those that might harbor life.

670 HELIOPHYSICS SCIENCE DIVISION

The Heliophysics Science Division (HSD) provides scientific leadership and expertise necessary to achieve NASA's strategic science goals in solar physics, heliospheric physics, geospace physics and space weather. It leads the definition and development of missions in support of these goals and performs fundamental research into solar structure and magnetic activity, the origins and acceleration of the solar wind, the effects of solar outbursts on the heliosphere, the response of the coupled magnetosphere-ionosphere system at the Earth and other planets to solar variability including solar irradiance. HSD's scientists develop coupled models of the sun and its corona, the heliosphere, geospace, and the high altitude environments of all of the planets, and they propose, develop and fly state-of-the-art instrumentation for photon and neutral atom imaging, electric and magnetic field mapping, and plasma and energetic charged particle measurements. HSD also designs and implements unique data systems that manage a wide range of solar-terrestrial data and enable rapid access and analysis across mission and discipline boundaries for the United States space science community. The scientists in the HSD interpret and evaluate data gathered from its instruments, draw comparisons with computer simulations and theoretical models, and publish the results. HSD's education and outreach activities communicate the excitement and societal relevance of NASA's operating and future Heliophysics missions.

671 SOLAR PHYSICS LABORATORY

The Solar Physics Laboratory leads in the exploration and understanding of the Sun as a star and the complex dynamics of the solar corona. It is in this region of the Sun's atmosphere that explosive releases of energy stored in magnetic fields give rise to the flares and coronal mass ejections that drive space weather throughout the solar system. Laboratory scientists conceive and carry out investigations that advance knowledge of the Sun and its variable output of light, solar wind plasma and embedded magnetic fields, energetic charged particles, x-rays, and gamma-rays. The Solar Physics Laboratory also develops new instruments and mission concepts, theoretical models, and innovative techniques to access and analyze data. Laboratory scientists support NASA's Science Mission Directorate by providing Project Scientists, contributing to strategic planning and mission definition, and communicating research results to the scientific community and the public.

672 HELIOSPHERIC PHYSICS LABORATORY

The Heliospheric Physics Laboratory leads in the exploration of the heliosphere through the conception and development of instruments and theoretical models designed to determine the origin and evolution of the solar wind, low energy cosmic rays, and the interaction of the Sun's heliosphere with the local interstellar medium. Laboratory scientists lead in the design and implementation of multi-disciplinary data services, innovative ground data systems, data modeling and visualization research. The Heliospheric Physics Laboratory supports NASA's Science Mission Directorate by providing Project Scientists and contributing to strategic planning and mission definition.

673 GEOSPACE PHYSICS LABORATORY

The Geospace Physics Laboratory mission is to advance knowledge of the coupled solar wind - magnetosphere - ionosphere system by means of experimental and theoretical investigations. Laboratory scientists are leaders in the development and implementation of plasma analyzers and low energy neutral atom imagers as well Geospace theory and modeling. The Geospace Physics Laboratory supports NASA's Science Mission Directorate by providing Project Scientists, contributing to strategic planning and mission definition, and communicating research results to the scientific community and the public.

674 SPACE WEATHER LABORATORY

The Space Weather Laboratory mission is to perform fundamental research and modeling of the coupled Sun-Earth system. The Laboratory undertakes spaceflight-based, ground-based, and theoretical and modeling studies of the space weather effects important to NASA and the nation. Laboratory scientists are leaders in the development and

implementation of electric and magnetic field instrumentation, ultra-violet imagers, and space environment theory and models. Space Weather Laboratory scientists serve as Project Scientists for NASA flight missions with space weather applications, and support strategic planning activities at NASA and other government agencies. The Laboratory also communicates NASA research results to the scientific community, other government organizations with space weather interests, and to the public.

690 SOLAR SYSTEM EXPLORATION DIVISION

The Solar System Exploration Division plans, organizes, evaluates, and implements a broad program of scientific research, both theoretical and experimental, to explore the solar system and to study the formation and evolution of planetary systems. The Division provides scientific expertise and leadership to support GSFC projects and to achieve NASA's strategic goals in the exploration of the Moon, Mars, and beyond.

Representative research questions addressed by the Division are:

- How do planets and planetary systems form, evolve, and diverge in their evolution?
- What processes determine the dynamics and evolution of planetary interiors, surfaces, and atmospheres?
- How and why does the Earth differ from the other terrestrial planets in our solar system and in extrasolar systems?
- What is the current and future state of the Earth, and what processes are changing it?
- How do the small bodies in the solar system form and evolve?
- Where are other habitable environments in the solar system?
- Is there now, or was there ever, life on other planets within our solar system?
- What are the characteristics of extrasolar planets, how do they compare with planets found in our own solar system, and what do they tell us about the origin and evolution of planetary systems and habitable planets?
- How do solar variations affect the planets, interplanetary space, and human explorers?
- What do we need to know in order to send explorers safely to the Moon and Mars, and what do they and their robotic partners do when they get there?

To do this the Division conducts a broad program of research in the areas of:

- Astrochemistry (comet ices, prebiotic organics, gas-phases, interstellar grains, asteroids)
- Planetary systems (planetary atmospheres, comets, extrasolar planetary systems)
- Planetary geodynamics (interiors, crustal evolution and dynamics, geology, topography, cratering, volcanism, orbital-rotational-climactic studies)

- Space geodesy (planetary gravity and rotation, time-variable gravity, geophysical fluids)
- Planetary magnetospheres (planetary magnetism and electrodynamics, radiowaves)
- Comparative planetary studies and studies of Earth as a planet (interior, geodynamics, atmospheric chemistry, geospace)
- Solar system data systems, EPO, and innovative instrument development
- Cross-cutting research areas in Astrobiology, Lunar Exploration, Mars Exploration

The Division personnel develop theoretical models of the origin and structure of solar systems and their objects, and the processes that alter them. They design experimental approaches and hardware to test these theories, and they collect, interpret, and evaluate data gathered from these experiments. They publish conclusions based on this experimental and theoretical research. They archive and disseminate the data, provide expert user support to the community, and undertake education and public outreach programs centered on the Division's science missions and services.

690.1 SOLAR SYSTEM EXPLORATION DATA SERVICES OFFICE

The SSEDS Office serves the Division as a key interface for coordinating data management and archiving plans within NASA's Science Mission. It supports the National Space Science Data Center (NSSDC) as a permanent archive for data associated with NASA missions that explore the Universe, Solar System, and Sun-Earth System and provides requested management support to the science active archive centers. In particular, the NSSDC, as the World Data Center for Satellite Information, serves as the distribution center for a broad range of space science satellite data and information. The NSSDC is responsible for the development, maintenance, and operation of discipline-independent inter-operable master catalogs, data standards, and other information services; support of NASA Headquarters with oversight function of preservation; and access to existing and future NASA space science archives. The NSSDC develops and integrates state-of-the-art capabilities and systems necessary to carry out its mission and is responsible for maintaining useful products and publications. The SSEDS maintains the necessary in-house expertise to support these and other data service activities, including those related to advanced information and storage technologies for distributed and intelligent data systems. The SSEDS also conducts programs in education and public outreach.

690.2 SPACE GEODESY PROJECT OFFICE

The Space Geodetic Systems Project Office (SGSPO) coordinates the management of NASA's contribution to the global ground network of geodetic observing systems. This includes management of: the operation of the NASA Space Geodetic Network; the support of NASA partner stations and facilities; the reduction, archiving, distribution, and analysis

of geodetic data; and the development and implementation of the next generation geodetic systems. The Office is also responsible for coordinating NASA's participation in the Global Geodetic Observing System and the Services of the International Association of Geodesy.

691 ASTROCHEMISTRY LABORATORY

Members of the Astrochemistry Laboratory propose and carry out measurements, observations and modeling of key rates and/or fundamental quantities that control important chemical processes in astrophysical and planetary environments or that yield the chemical and isotopic compositions of solar system bodies. Members also perform simulations of natural processes or synthesize simplified analog samples of natural materials in order to better understand the unexpected consequences of natural events or to record the spectroscopic properties of well characterized samples for comparison with observations.

691.1 SOLAR SYSTEM EXPLORATION GRANTS SUPPORT OFFICE

The Solar System Grants Support Office serves the NASA Headquarters Solar Systems Exploration Division in the implementation of funding plans for NASA Headquarters Research and Analysis programs. The Office is responsible for preparing procurement request documents for submission to the NASA Grants Procurement Office and to the NASA Contracts Procurement Office, for facilitation of funding annual awards to several hundred planetary science Principal Investigators (total budget in 2005 - $60M/yr.). Office personnel track procurement requests, provide follow-up information during the award process, interact with NASA Headquarters Resource Analysts and with NASA Peer Review Services personnel, and remain current with changes in procurement request submission and tracking procedures. The Head of the Office serves as an ombudsman to the university community regarding grant and contract issues, serves as Technical Officer on these grants and contracts, and oversees the work of Office support personnel.

693 PLANETARY SYSTEMS LABORATORY

The Planetary Systems Laboratory conducts research in the origin of the Sun's family of planets and minor bodies, and their evolution to their current state. This research improves the understanding of the composition and dynamics of planetary atmospheres and surfaces, including the current and evolutionary processes which act to shape and maintain these atmospheres and surfaces. The properties and evolutionary history of our solar system are studied in the context of planetary systems surrounding other stars, including comparing the Sun's planets with extrasolar planets, and understanding how life begins and evolves in planetary systems.

694 LASER REMOTE SENSING LABORATORY

The Laser Remote Sensing Laboratory formulates, designs, and develops laser remote sensing techniques, instruments and advanced mission concepts for scientific measurements of the planets in the solar system, including the Earth. Measurements include planetary topography, surface and vegetation change detection, atmospheric constituent analysis, and precision ranging with applications in planetary geodynamics, biomass estimation (on Earth), atmospheric profiling, space geodesy, and optical communications. Laboratory personnel have broad experience in the analysis and development of both active and passive sensors for ground-based, airborne and spaceborne platforms. Activities include planning and participating in scientific field campaigns, analyzing the laser measurement and laser sensor performance, acquiring and interpreting Lidar data, and developing lasers, optics, and detector components.

695 PLANETARY MAGNETOSPHERES LABORATORY

The Planetary Magnetospheres Laboratory advances planetary exploration by research concerning planetary magnetospheres, including the origins and evolution of planetary magnetic fields and associated electromagnetic emissions. This includes the study of underlying fundamental physical processes, the impact of solar events on planetary environments as observed by radio emissions, and the scientific formulation of related advanced space architecture and mission concepts for solar system research and their development in partnership with Goddard's engineers as well as other NASA centers and outside laboratoriessystem, and its dynamic interactions. The worldwide geodetic Very-Long-Baseline Interferometry is coordinated from the Laboratory. Members also conduct research that results in frontier models in ocean tides, and core dynamics of Earth and other planetary bodies. The Laboratory's research leverages actively on collaborations with researchers from the outside scientific community.

698 PLANETARY GEODYNAMICS LABORATORY

The Planetary Geodynamics Laboratory conducts research into the structure, dynamics and evolution of the Solid Earth and Planets using in situ and remote sensing data, to better understand: (1)The dynamics of the solar system and the climatic and potential impact effects that result for us on Earth; (2) How and why the Earth is similar to – and different from – other planetary bodies in our solar system; (3)The current and likely future state of the Earth, especially as regards hazards to humans; and (4)The likely location of other habitable environments in the solar system. These investigations include the broad disciplines of Earth and planetary geophysics, geology and geodesy and involve mission studies, measurements, and modeling.

699 PLANETARY ENVIRONMENTS LABORATORY

The Planetary Environments Laboratory studies the chemistry of atmospheres and surfaces of planets and their moons and develops instruments for robotic spacecraft sent to these planetary exploration targets. The Laboratory members lead experiment based science investigations to explore the chemical and isotopic composition of planetary targets. These targets of past and future interest include the atmospheres of the Venus, Mars, Titan, and the gas giants Jupiter and Saturn and the more tenuous atmospheres of comets, the moon, and icy moons in the outer solar system. Also of interest are volatiles and organic compounds in rocks on Mars and hydrocarbon lakes on Titan and in meteoritic samples delivered to Earth. Laboratory personnel participate in all phases of these investigations, from defining and developing the specialized instruments required to analyzing, interpreting, distributing, and archiving of the data collected during flight missions. A basis for these mission studies is provided through a vigorous program of planetary analog research that includes laboratory simulations of planetary environments and chemistry, geochemical and isotopic analysis, and field studies of planetary analog sites. Related theoretical work in the Laboratory includes computational modeling of solar wind interactions with planetary bodies, general circulation models of present and ancient planetary atmospheres, and geochemical modeling. Research is directed toward understanding the habitability of diverse environments in our solar system and understanding the origin and evolution of planets and more primitive solar system objects.