NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Principal Areas of Focus

The mission of NASA's Earth Science Enterprise is to understand and protect our home planet by using our view from space to study the Earth system and improve prediction of Earth system change. NASA programs are aimed at understanding the Earth system and applying Earth system science to improve prediction of climate, weather, and natural hazards in partnership with other Federal agencies and international space and research programs. NASA's Research Strategy orchestrates observing and modeling programs to address these essential questions:

- How is the Earth changing, and what are the consequences for life on Earth?
- How is the global Earth system changing?
- What are the primary causes of change in the Earth system?
- How does the Earth system respond to natural and human-induced change?
- What are the consequences of change in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

NASA's portfolio includes observations, research, analysis, modeling, and advanced technology development, in order to answer selected science questions, and benchmarking decision support resources to ensure society receives the benefits of this research.

NASA pioneered the interdisciplinary field of Earth system science which explores the interaction among land, oceans, atmosphere, ice, and life. To study these interactions, NASA has developed and deployed the Earth Observing System (EOS) and related satellites, and suborbital and surface-based sensors— collecting, processing, archiving, and distributing these data through the EOS Data and Information System (EOSDIS). Distributing more than 25 million data products in response to more than 2.3 million users each year, EOSDIS is the largest "e-science" system in the world. Following the Earth system science construct, NASA has organized its research into six science focus areas. The table below identifies these six focus areas and how they align with the CCSP research areas.

CCSP RESEARCH ELEMENTS	EARTH SCIENCE ENTERPRISE SCIENCE FOCUS AREAS
Atmospheric Composition	Atmospheric Composition
Climate Variability and Change	Climate Variability and Change
Global Water Cycle	Global Water and Energy Cycle
Land-Use/Land-Cover Change Global Carbon Cycle Ecosystems	Carbon Cycle and Ecosystems
Human Contributions and Responses	
	Weather
	Earth Surface and Interior

Recent Accomplishments

- Produced the most accurate map yet of the Earth's gravity field from the twin Gravity Recovery And Climate Experiment (GRACE) satellites, improving from 10 to 100 times the accuracy of previously existing assessments. Ultimately, GRACE will help determine the distribution of mass under the Earth's surface, including the change in volume of large aquifers.
- Instruments on the Aqua satellite are generating the most accurate, highest resolution measurements ever taken from space of the infrared brightness of Earth's atmosphere, yielding a global, three-dimensional map of atmospheric temperature and humidity.
- The Eurasian and South American continents are the latest for which detailed topographic data have been processed and released from the Shuttle Radar Topography Mission, for use in a wide variety of scientific investigations and practical applications.
- NASA satellite observations have provided the first evidence that the rate of ozone depletion in the Earth's upper atmosphere is decreasing. This decrease is consistent with the decline in abundance of human-made chlorine and bromine-containing chemicals previously documented by satellite, airborne, and ground-based sensors.
- The USDA Forest Service is using data from NASA satellites to understand how fires behave before, during, and after their damage has been done. After a fire is contained, imagery from space helps classify the burn area into levels of severity for prioritization of rehabilitation work. These satellites also keep daily track of the carbon monoxide plumes from fire and the scope of pollution produced regionally and globally.
- Recent research has found perennial, or year-round, sea ice in the Arctic is declining at a rate of 9% per decade and that in 2002 summer sea ice was at record low levels. Early results indicate this persisted in 2003. The Arctic warming study—appearing in the 1 November issue of the American Meteorological Society's *Journal of Climate*—shows that, compared to the 1980s, most of the Arctic warmed significantly over the last decade, with the biggest temperature increases occurring over North America.

Program Highlights for FY 2004 and FY 2005

FY 2004

- Complete deployment of the first phase of EOS with the launch of the Aura satellite. Aura will make a variety of measurements of atmospheric composition, including the first measurements of global tropospheric ozone and precursors.
- Use satellite observations to provide daily and seasonal global atmospheric water vapor, rainfall, snowfall, sea ice, and ice sheet maps, and use these observations to improve the scientific understanding and models of the global cycling of water through the Earth system.
- Use satellite-derived localized temperature and moisture profiles of unprecedented accuracy and global coverage to improve predictive capabilities of regional weather models.
- Assimilate satellite and *in situ* observations into a variety of ocean, atmosphere, and ice models for the purpose of estimating Earth's seasonal and decadal climate.
- Demonstrate the benefits of formation-flying multiple satellites in a constellation for the first time (i.e., creating a supersatellite) to enable generation of integrated science information products (e.g., aerosol distribution, optical thickness, and properties to assess their total effect on climate).

FY 2005

- Launch the Cloudsat and Calipso satellites to obtain the first global three-dimensional measurements of cloud structure and aerosol distribution, to reduce key uncertainties in climate forcing.
- Continue development of missions to measure ocean topography, ocean surface winds, global precipitation, sea surface salinity, atmospheric carbon dioxide, and aerosol properties, as well as development of the preparatory mission for the next generation converged polar-orbiting operational environmental satellite system.
- Select new missions under the fourth Earth System Science Pathfinder Announcement of Opportunity.
- Integrate satellite, suborbital, and ground-based observations to assess the potential for future ozone depletion in the Arctic.
- Improve predictive capabilities of regional models for hurricane tracks and landfall using satellite-derived localized temperature and moisture profiles and ensemble modeling.
- Assimilate satellite and *in situ* observations into a variety of ocean, atmosphere, and ice models for improved state estimation and experimental prediction on a variety of climatological time scales, and determine plausibility of predictions through validation strategies.

Related Research

Outside the scope of the CCSP, NASA's Earth Science Enterprise also conducts research and observing missions to study the solid Earth and related natural hazards. The Earth Science Enterprise also manages an Earth Science Applications program in partnership with other Federal agencies, State and local governments, academia, and industry to test new uses of remote-sensing data to solve practical societal problems in twelve applications of national priority:

National Application	Partner Agencies
Renewable Energy	DOE, EPA
Agricultural Efficiency	USDA, EPA
Carbon Management	USDA, EPA, DOE, USGS, USAID
Aviation	DOT/Federal Aviation Administration
Homeland Security	Department of Homeland Security, National Governors Association, USDA, USGS, NOAA, DOD
Ecological Forecasting	USGS, USDA, USAID
Disaster Preparedness	Federal Emergency Management Agency, USGS, NOAA, USDA
Public Health	CDC, DOD, NIH, EPA, USGS , NOAA
Coastal Management	NOAA, EPA
Invasive Species	USGS, USDA
Water Management	Bureau of Reclamation, USGS, EPA, USDA
Air Quality	EPA, NOAA, USDA, FAA