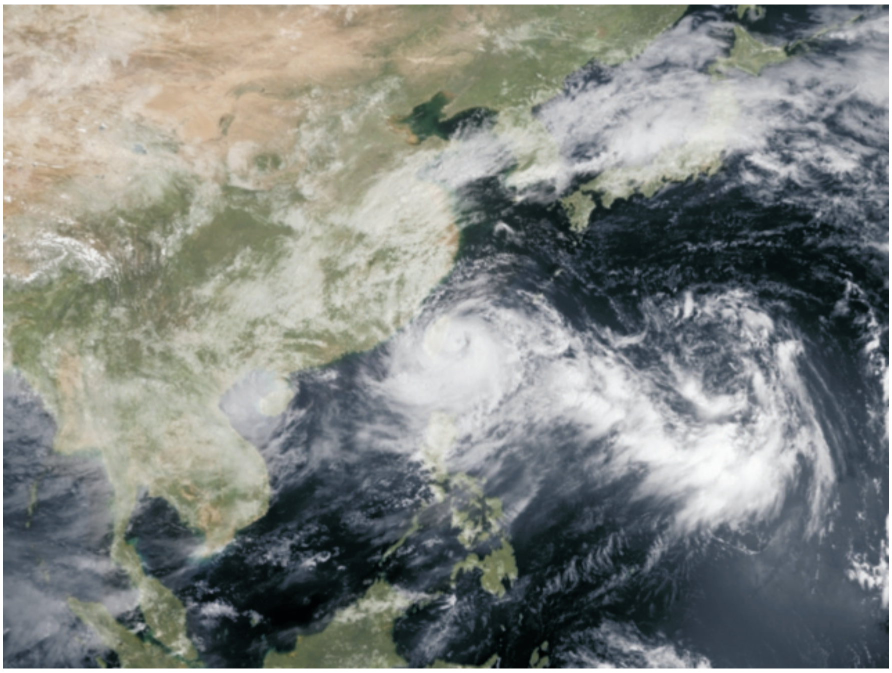
Understanding the Earth

The prevailing view of NASA is mainly concentrated around spectacular missions to the International Space Station, to the moon and beyond etc., but NASA is much more. NASA also manages the world's most advanced and most comprehensive programmes for observations on. The organization operates fifteen satellite missions that produce close to 4 terabytes of data every day. Through these satellite sensors, NASA operates and controls the world's largest scientific data and information system for collecting, processing, archiving, and distributing earth system data to users worldwide.



"To fully understand the system on earth as well as the changing climate."

This image, taken August 7, 2009 shows the typhoon Moracot threating Taiwan. The typhoon dumped more than 2000 mm of rain over the island and caused the worst flooding in half a century. Photo: NOAA

NASA's ambitious goal is to fully understand the system on earth as well as the changing climate, and in association with national and international partners apply this understanding for the well-being of society. A key strategic element is sustained simultaneous observations to unravel the complexity of the global integrated earth monitoring system. In addition to the fifteen operative satellites NASA has today, five new missions are being defined, developed or, said in another way; pre engineered. Two missions are scheduled to be launched about late 2013 and early 2015, while the remaining three are in pre-formulation stages.

Seven in-orbit satellite missions provide data in near-real time to the National Oceanic and Atmospheric Administration (NOAA) for operational forecasts of weather, hurricanes, air quality, and harmful algal blooms, while the rest are different research satellites. Ten of the in-orbit missions are conducted applying fourteen different international partners.

NASA's Earth Observation Programmes are divided in six different areas, Earth Science Research, Earth Systematic Missions, Earth System Science Pathfinder, Earth Science Multi-Mission Operations, Earth Science Technology and Applied Sciences

Earth Science Research

The Science Mission Directorate issues the Research Opportunities in Space and Earth Science (ROSES), a research announcement covering all of the planned research solicitations in the Earth Science Research for the following years. Roughly a third of the Earth Science Research budget is completed each year through ROSES. The resulting grants are generally funded for three years following the selections.

On-going scientific research areas on earth, including ocean circulation, are the effect of decreasing sea ice coverage on the climate, energy and water cycles, arctic research of the composition of the troposphere, geodetic imaging, global modelling of the earth system, hurricane science and biodiversity.

In this respect, NASA has already initiated a new Airborne Science Campaign, called IceBridge, to "bridge the gap" between ICESat I and ICESat II data. This activity, focusing on changes in Greenland and the Arctic ice, will continue in 2010 and beyond.

Earth Systematic Missions

To fulfil the goals identified in the report, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond", the Soil Moisture Active-Passive (SMAP) and Ice, Cloud, and Land Elevation Satellite (ICESat II) missions will be pursued aggressively, leading to projected launches between late 2013/early 2015. Studies of two new missions, the Climate Absolute Radiance and Refractivity Observatory (CLARREO) and the Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI), will also be intensified.

The Earth Systematic Missions (ESM) Programme provides a number of earth-observing satellites that contribute to the provision of long-term environmental data sets that can be used to study the evolution of the earth system on a range of temporal scales. NASA works with the science community to identify scientific questions on the frontiers of science that have profound societal importance, and to which on-going remote sensing of the earth can make a defining contribution. These scientific questions become the foundation of a research strategy, which defines requirements for scientific observations through the vantage point of space. Each of Earth Science's six focus areas has an implementation roadmap that shows what role space-based observations play in meeting overall science objectives. The six Earth Science focus areas are as follows: Climate variability and change; Atmospheric composition; Carbon cycle, ecosystems, and biogeochemistry; Water and energy cycles; Weather; and Earth surface and interior. This effort also provides techniques and technologies that can be employed to predict climate, weather and natural hazards on planets they plan to explore.

Earth System Science Pathfinder

In these programmes NASA seeks answers to some of the basic questions connected to general Earth Science. The mission closest to its launch in 2010 is the Aquarius/SAC-D observatory.

Aquarius is a focused satellite mission designed to measure global Sea Surface Salinity. After its launch, it will provide the global view of salinity variability needed for climate studies. The Aquarius / SAC-D mission is being developed by NASA and the Space Agency of Argentina.

NASA is also working on how best to meet the lost scientific contributions after the Orbiting Carbon Observatory (OCO) launch vehicle failure earlier this year. Studies are carried out to examine both science and hardware considerations. The scientific study is assessing the current state of carbon cycle science and existing measurements to see what course of action would best address the key scientific issues. With regard to the hardware, NASA is examining re-flight opportunities, including, but not limited to, flying an OCO-like instrument on a shared platform or as a dedicated mission.

In response to the report, "Earth Science and Applications from Space", NASA is initiating a new series of competed "Venture-class" missions. These missions, which may include suborbital payloads, instruments to be flown on non-NASA spacecrafts, or small dedicated spacecrafts, will be selected via an announcement of opportunity. Selection of the first Venture-class mission(s) is planned for 2010.

Earth Science Multi-Mission Operations

The Earth Science Multi-Mission Operations Program will continue the operation of the "Earth Observing System Data and Information System" (EOSDIS). The maintenance of these systems is important to the collection of data from Earth Science satellites in orbit, as well as to the continuity of Earth Science research efforts.

Earth Science Technology

The Earth Science Technology Program (ESTP) will develop new remote-sensing and information system technologies for infusion into future scientific missions to enable, or dramatically enhance, measurements and data system capabilities, a programme in order to further develop and manage the large amount of data from the different types of earth observation data.

Applied Science

The Applied Sciences Program will continue to work across the range of application areas, especially focusing on supporting communities as they plan for and respond to the impacts of climate change. Its ultimate aim is to incorporate earth science data into decision making activities for policy and management. The Applied Sciences Programme used this study to identify the best practices and to benchmark its approaches on strategic planning, implementation, partnership development, and administration.

OCO- A Mission Not Accomplished

The Orbiting Carbon Observatory (OCO), a satellite one had high expectations to, unsuccessfully launched and was totally lost early this year. Its main mission was to detect the current state of the carbon cycle in the atmosphere. The loss of the satellite was an enormous setback for the research activities connected to the carbon cycle and NASA is now examining different re-flight opportunities.

Incessant delays and cost overruns for a NPOESS-sensor

Another problem is the next generation operational polar orbiting satellites, NPOESS. One of the sensors for this satellite, Visible/Infrared Imaging Radiometer Suite is slated to fly on the two first new NPOESS satellites, as well as the NPOESS Preparatory Project (NPP). The Visible/Infrared Imaging Radiometer Suite, designed to monitor cloud formations and other atmospheric and ocean-surface phenomena has been a constant problem for NOPESS and has contributed to restructuring of the whole project, steady delays of the satellite and large cost overruns. NPP was planned for launch in 2010 but is now slated to launch in January 2011 and the first NPOESS will not be launched until May 2014.

The constant delays and cost overruns have raised questions about the managing of the project furthermore, it has raised questions about whether one should completely restructure the project management.

For more information, see http://science.hq.nasa.gov/missions/earth.html.

The A-train Constellation

An example of both the American involvement and the international collaboration is the satellite constellation; the so-called A-train, five different satellites placed in close proximity in orbit that pass the same point of earth with short intervals. The afternoon A-train consists of the following satellites; NASA's Aqua, Aura, CALIPSO, Cloudsat and the French PARASOL. The OCO satellite, recently lost in an unsuccessful launch, should have been the sixth in the train. NASA's Glory will also join the constellation when the satellite is to be launched.

Each satellite within the A-Train has unique measurement capabilities that greatly complement each other. For the first time, near simultaneous measurements of aerosols, clouds, temperature, relative humidity, and radiative fluxes (the change of radiation in a layer) will be obtained across the globe during all seasons. This ensemble of observations will allow one to understand how large scale aerosol and cloud properties change in response to changing environmental conditions. It will further allow one to determine how changing cloud and aerosols distributions influence our climate with greater clarity than possible before.

For much of its life, the A-Train will be maintained in orbit within 15 minutes of the leading and trailing spacecraft while traveling over 15,000 miles per hour. CloudSat and CALIPSO will be controlled to an even finer requirement, within 15 seconds of each other, so that both instrument suites will view the same cloud area almost simultaneously. This capability is crucial for studying clouds, most of which have a lifespan of less than 15 minutes.

The constellation has a nominal orbital altitude of 705 km and inclination of 98 degrees. Aqua will lead the constellation with an equatorial crossing time of about 1:30 PM. CloudSat and CALIPSO lag Aqua by 1 to 2 minutes and will be separated from each other by 10 to 15 seconds.

The satellites in the A-Train are maintained in orbit to match the World Reference System 2 (WRS-2) reference grid. This reference system was developed to facilitate regular sampling patterns by remote sensors in the Landsat program. Each satellite completes 14.55 orbits per day with a separation of 24.7 degrees longitude between each successive orbit at the equator. The orbit tracks westward 10.8 degrees on succeeding days, which over a 16-day period produces a uniform WRS grid over the globe. The WRS grid pattern consists of 233 orbits with separation between orbits at the equator of 172 km.