Science Mission Directorate

Update on NASA

Presented at the Unidata Policy Committee Meeting

16 May 2005

Michael Goodman
Earth-Sun System Division
NASA Headquarters
With the Launch of Aura, the 1st Series of EOS is Now Complete
Over 30 NASA Earth – Sun Research Spacecraft
Earth System Science
a. Interdisciplinary research
b. Global observations

Development of observing capability
a. Innovative technology development
b. Space-based observations

Pioneer use of remote sensing to improve prediction of weather, climate and natural hazards
a. Modeling
b. Integration of Earth observation, advanced technology, and interdisciplinary research
How is the Earth changing and what are the consequences of life on Earth?

How is the global Earth system changing?

What are the primary forcings of the Earth system?

How does the Earth system respond to natural and human-induced changes?

What are the consequences of changes in the Earth system for human civilization?

How well can we predict future changes in the Earth system?
Science Questions and Focus Areas

Variability
- Precipitation, evaporation & cycling of water changing?
- Global ocean circulation varying?
- Global ecosystems changing?
- Atmospheric composition changing?
- Ice cover mass changing?
- Earth surface transformation?

Forcing
- Atmospheric constituents & solar radiation on climate?
- Changes in land cover & land use?
- Motions of the Earth & Earth’s interior?
- Atmospheric composition changing?
- Ice cover mass changing?
- Earth surface transformation?

Response
- Clouds & surface hydrological processes on climate?
- Ecosystems, land cover & biogeochemical cycles?
- Changes in global ocean circulation?
- Atmospheric trace constituents responses?
- Sea level affected by Earth system change?

Consequence
- Weather variation related to climate variation?
- Consequences of land cover & land use change?
- Coastal region impacts?
- Regional air quality impacts?
- Sea level affected by Earth system change?

Prediction
- Weather forecasting improvement?
- Improve prediction of climate variability & change?
- Ozone, climate & air quality impacts of atmospheric composition?
- Carbon cycle & ecosystem change?
- Change in water cycle dynamics?

Climate Variability and Change
Carbon Cycle and Ecosystems
Water and Energy Cycle
Atmospheric Composition
Weather
Earth Surface and Interior

Predict & mitigate natural hazards from Earth surface change?
Focus Area Integration via Earth System Modeling
Integrating Knowledge, Capacity and Systems into Solutions

Integrated Earth Observations System Framework Architecture

Earth System Models
- Oceans
- Atmosphere
- Land
- Solid Earth
- Biosphere
- Cryosphere

Earth Observation Systems
- Satellite
- Airborne
- Surface

Data

Predictions and Forecasts

Decision Support System
- Assessment
- Tools

Policy Decisions

Management Decisions

Personal Decisions

Societal Benefits

On-going feedback to optimize value and reduce gaps
Focus on Societal Benefits

- Reduce Losses From Disasters
- Protect Water Resources
- Ecological Forecasts
- Human Health & Well-Being
- Manage Energy Resources
- Sustainable Agriculture and Forestry
- Ocean Resources
- Improve Weather Forecasting
- Climate Variability & Change
U.S. Plans for Extending NASA Science Results

U.S. Commercial Remote Sensing Space Policy: Civil Agency Implementation Plan

December 12, 2003

Implementation Plan Working Group (IPWG)
Co-chaired by:
- Ghassem Asrar (NASA)
- Teresa Fryberger (OSTP)
- Greg Withee (NOAA)

### U.S. Agencies Related To Societal Benefit Areas

#### TABLE KEY
- **P** = primarily provides data
- **U** = primarily uses data
- **B** = uses/provides data

#### Societal Benefit Areas

<table>
<thead>
<tr>
<th>Benefit Area</th>
<th>DOC/NIST</th>
<th>DOD</th>
<th>DOE</th>
<th>DHHS/NIH</th>
<th>DHS/FEMA</th>
<th>DOJ/USGS</th>
<th>DOS</th>
<th>DOT</th>
<th>EPA</th>
<th>NASA</th>
<th>NSF</th>
<th>TVA</th>
<th>Smithsonian</th>
<th>USAID</th>
<th>USDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>P B B U U U U B U B U U U B B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disasters</td>
<td>P U U U U U B U U U P B U U U U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oceans</td>
<td>B B B U U B U P B U U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate</td>
<td>B U B U U B U U U B B B B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>P U U U U P U P B U B P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Health</td>
<td>P P B B U B P B U B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecology</td>
<td>B B U B B B B B B B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>B B U U B B B B B U U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>P B B U U B P U B P U U U U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Near-Term Opportunities

A. Data Management

B. Disaster Warnings

C. Global Land System

D. Sea Level System

E. Drought System

F. Air Quality System
A. Data Management System for Earth Observations

- Data Sharing
- Processing facilities
- Access and archival
- Data transfer
- Web services
- Standards and Interoperability
B. Improved Observations for Disaster Management
C. Global Land Observation Systems

Global Land Cover Facility
Earth Science Data Interface

Map Size: 500x250
Color Map:  

Landsat Imagery
- ETM+
- TM
- MSS

Elevation Data
- SRTM, Degree Tiles
- SRTM, WRS2 Tiles
- SRTM, GTOPO30
- SRTM, GTOPO30 Mosaic

MODIS Products
- 32-Day Composites
- 16-Day Vegetation Index
- Vegetation Continuous Fields

AVHRR Products
- Global Land Cover, Regional
- Global Land Cover, Global
- Continuous Fields Tree Cover, Regional
- Continuous Fields Tree Cover, Global

Date/Type  Path/Row  Lat/Long  Place  Draw  Map Layers

1 image(s) in selection  Preview & Download  Update Map

Enter dates as mm/dd/yyyy or yyyy-mm-dd

Start Date:  
End Date:  

New Since:  Months ago

Require  Exclude

GeoCover  GeoCover

San Diego  Baja California  Nevada  Sonora  Phoenix  Los Angeles
D. Sea Level Observation Systems

HABSOS
Real-Time Observations and Models

You have selected to either have a layer displayed or not displayed on the map. This will not happen until you click on the Refresh Map button.
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm
F. Air Quality NowCast

The U.S. EPA has developed the AIRNOW website to provide the public with easy access to national air quality information. This website offers daily Air Quality Index forecasts as well as real-time conditions for over 300 cities across the U.S.

Ozone and PM2.5 Forecasts

The color-coded map represents the Air Quality Index (AQI) levels, ranging from 0 to 100, with different colors indicating varying levels of air quality:
- Green: Good
- Blue: Moderate
- Gray: Sensitive
- Yellow: Unhealthy
- Red: Very Unhealthy
- Black: Derailed

The map is color-coded to indicate AQI levels, with lower numbers indicating better air quality and higher numbers indicating poorer air quality.

NASA, NOAA, and EPA logos are present, indicating the collaboration and support from these agencies.

The date 2004 07 23 16Z is shown, indicating the time and date of the air quality data.
Evolution of EOSDIS Elements
Data Acquisition to Data Access

Data Acquisition
- Spacecraft
- Polar Ground Stations
- Tracking & Data Relay Satellite (TDRS)
- Ground Stations

Flight Operations, Data Capture, Initial Processing & Backup Archive
- Data Processing & Mission Control

Data Transport to DAACs
- NASA Integrated Services Network (NISN) Mission Services

Science Data Processing, Data Management, Data Archive & Distribution
- EOSDIS Science Data Systems (DAACs and SIPS)
- REASoNs
- Data Pools

Distribution, Access, Interoperability & Reuse
- WWW IP Internet
- Research
- Education
- Value-Added Providers
- Interagency Data Centers
- Earth System Models
- Use in Earth System Models
- Benchmarking DSS

TECHNOLOGY
Earth System Data Resides in Distributed Active Archive Centers (DAAC)

- **NSIDC (67 TB)**
  - Cryosphere
  - Polar Processes

- **LPDAAC-EDC (1143 TB)**
  - Land Processes & Features

- **SEDAC (0.1 TB)**
  - Human Interactions in Global Change

- **GES DAAC-GSFC (1334 TB)**
  - Upper Atmosphere
  - Atmospheric Dynamics, Ocean Color, Global Biosphere, Hydrology, Radiance Data

- **ASDC-LaRC (340 TB)**
  - Radiation Budget, Clouds, Aerosols, Tropospheric Chemistry

- **ORNL (1 TB)**
  - Biogeochemical Dynamics
  - EOS Land Validation

- **PODAAC-JPL (6 TB)**
  - Ocean Circulation
  - Air-Sea Interactions

- **ASF (256 TB)**
  - SAR Products
  - Sea Ice
  - Polar Processes

- **GHRC (4TB)**
  - Global Hydrology

- **LPDAAC-EDC (1143 TB)**
  - Land Processes & Features
Goal: assess the current state of EOSDIS in order to identify the components that:

- can/must evolve,
- need to be replaced because of the rapid evolution of information technologies, and
- require a phase-out strategy because they are no longer needed.

This study should provide findings and options for evolution of elements of EOSDIS in order to:

- Increase end-to-end data system efficiency and operability
- Increase data usability by the science research, application, and modeling communities
- Provide services and tools needed to enable ready use of NASA’s Earth science data in the next-decadal models, research results, and decision support system benchmarking
- Improve support for end users
NASA’s research communities have access to all EOS data through services at least as rich as any contemporary science information system, for example:

- Data access latency is no longer an impediment
- The physical location of data storage is irrelevant
- Finding data is based on common search engines (e.g., Google2015)
- Services are primarily invoked by machine-to-machine interfaces
- Multiple data and metadata streams can be seamlessly combined
- Custom processing (e.g., subsetting, averaging, reprojection) provides only the data needed, the way they are needed
- Open interfaces and best practice standard protocols are universally employed

The research and value-added provider communities use EOS data interoperably with any other relevant data sources (e.g., NPOESS, METOP, GPM, numerical models, *in situ* systems) and systems (e.g., Global Earth Observation System of Systems).
The EOS archive holdings are regularly peer reviewed for scientific merit:

- Procedures for such reviews have been developed and tested over a decade
- Derived products that are not deemed scientifically useful are phased out.

Mechanisms to collect and preserve the pedigree of derived data products are readily available.

Processing and data are mobile: processing can be moved to data and/or data can be moved to processing.

NASA data systems have evolved into components that allow fine-grained control over cost drivers.

Expert knowledge is readily accessible to enable researchers to understand and use the data.
“Accelerating the realization of economic and societal benefits from NASA science, information, and technology …”
BACKUP
Earth-Sun System Models
Next Generation Missions

NPOESS Preparatory Project
Landsat Data Continuity Mission Instruments
Ocean Surface Topography Mission

Ocean Vector Winds Mission
Global Precipitation Measurement
Aerosol Polarimeter Sensor Instruments

Synthetic Aperture Radar
Chemistry/Climate Mission
Cryosphere Monitoring Mission

Calipso
Orbiting Carbon Observatory
Cloudsat
Aquarius

Hydros

Candidate Future Missions
In Formulation/Preformulation or in Development

Next generation systematic measurement missions to extend/enhance the record of science-quality global change data
Research missions to probe key Earth system processes globally for the first time
Future research Measurements