The NASA SMD Earth Science Division supports basic and applied research on the Earth system and its processes. Primary efforts are to characterize, understand, and improve predictions of the Earth system.

- *Technology*
- *Missions*
- *Research*
- *Data Systems*
- *Applications*

A Space Program with a comprehensive, broad-based scientific research, technology, and applications element.

A scientific research, technology, and applications program with expertise and access to space.
Earth as a Complex Inter-related System

Atmosphere
- Circulation
- Surface Winds
- Precipitation
- Reflection and Transmission
- Surface Temperature
- Evaporation
- Transpiration

Ocean
- Upwelling
- Currents

Land
- Infiltration
- Runoff
- Nutrient Loading
- Surface Temperature
- Currents

Surface Winds
Precipitation
Reflection and Transmission
Evaporation
Surface Temperature
Discovering and demonstrating innovative and practical applications of Earth Science

The Applied Sciences Program funds projects that enable uses of Earth observations in organizations’ policy, business, and management decisions.

**Applications**
Hands-on projects and studies to prove-out and demonstrate applications ideas targeted at integrating Earth observations in specific decision-making activities (e.g., economic, resource management, health)

**Capacity Building**
Projects and activities to build skills, users, and capabilities in the US and developing countries on how to access and apply environmental satellite data to benefit society

http://AppliedSciences.NASA.gov
Discovering and demonstrating innovative and practical applications of Earth Science

The Applied Sciences Program funds projects that enable uses of Earth observations in organizations’ policy, business, and management decisions.

Accelerate Applications
Enable identification of applications early in satellite mission lifecycle and facilitate effective ways to integrate end-user needs (e.g., non-research uses) into satellite mission planning and throughout the mission life cycle.

http://AppliedSciences.NASA.gov
Applications Areas

Emphasis in 4 Applications Areas

- Health & Air Quality
- Water Resources
- Disasters
- Ecological Forecasting

Seek opportunities to expand to 5 additional areas

- Agriculture
- Climate
- Weather
- Energy
- Oceans
Earth Observations of Environmental Conditions

Image from NASA Earth Observatory

Data from NASA Goddard Space Flight Center, Image processed by Battelle

True Color

Aerosols & Particulates

Northern India, Nepal, and Bangladesh
Ecosystems:
Fire Monitoring and Alerts
**Information Delivery: Fires**

**Challenge:** Fire managers (especially in remote locations) need timely information on fires still burning in and around their areas of responsibility.

*Terra & Aqua* satellites possess sensors to identify thermal anomalies and active fire locations.

Fire Information Sent Out via Rapid Response System

Email alerts, SMS/Text messages, images, active fire data
UN FAO now operates this Global Fire Info Management System


Terra & Aqua satellites possess sensors to identify thermal anomalies and active fire locations.
Tropical Depression 12-E brought record-breaking amounts of rain to El Salvador in October 2011, resulting in widespread floods, landslides, 34 deaths, and significant damages to infrastructure.

LANDSAT images used to estimate inundated areas

SERVIR took the following actions:
- Tasked NASA satellites to image affected areas (ASTER and EO-1) and commercial satellite imagery
- Communicated with government agencies in El Salvador to identify needs and high priority areas to image

Quickbird-2 image (left) compared with recent Google Earth image
The record-breaking drought in Texas has reduced stored groundwater to near the driest levels on record since 1948, according to new maps produced by NASA's Goddard Space Flight Center that are publicly available on the website of the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln.

The Drought Center now distributes three maps each week based on the GRACE satellite data, one showing long-term fluctuation in deep groundwater, another showing change down to a meter below the surface and a third that shows change in the top two centimeters. The shallower layers change more rapidly in response to rain.

The Drought Center’s Brian Wardlow said the tool provides information about changes in the water content of aquifer systems. stating "This gives policy makers new insight into subsurface water fluctuations at regional to national scales that has not been available in the past."

(wetness percentiles relative to the period 1948-present) for 25 July 2011
Earth Observations

U.S. Space Policy (2010)

Facilitate new market opportunities for U.S. commercial space capabilities and services, including commercially viable terrestrial applications that rely on government-provided space systems;

Promote the adoption of policies internationally that facilitate full, open, and timely access to government environmental data;

NASA, NOAA, and USGS shall:
Continue to develop civil applications and information tools based on data collected by Earth observation satellites.
Applied Sciences Solicitation Language:
The Program considers that Earth observations broadly include a range of products and capabilities including:

» Earth-observing satellite measurements (NASA, USG, foreign, commercial satellites),
» Outputs and predictive capabilities from Earth science models, algorithms, visualizations
» Other geospatial products.

Proposals can include data products from non-NASA satellites, including foreign and commercial satellites, if used in conjunction with some NASA observations, models, or capabilities.

The NASA Science Mission Directorate has adopted commercial data purchases as a mainstream way of acquiring research-quality data, as these commercial capabilities become available. The use of commercially-available data sets by Principal Investigators is an allowable expense, as long as the data meets the scientific requirements.
Applied Sciences Solicitation Language:
The Program allows and strongly encourages private sector companies (and teams of companies) to submit proposals and/or be involved in project teams.

The Program strongly encourages multiorganizational, multidisciplinary, and multisectoral teams.

Criteria under Intrinsic Merit:
Quality of teaming across appropriate sectors and areas of expertise and the involvement of end-user organization(s) in the project.
Applications Readiness Levels

ARLs

8. Application Completed and Qualified.
6. Demonstrate in Relevant Environment.
5. Validation in Relevant Environment.
4. Initial Integration and Verification (in Laboratory Environment).
3. Proof of Application Concept.
2. Application Concept.
1. Basic Research.
The national strategy outlined here has as its overarching objective a program of scientific discovery and development of applications that will enhance economic competitiveness, protect life and property, and assist in the stewardship of the planet for this and future generations.

*Earth Science Decadal Survey*
Level 1 Requirements document identifies the mission, science and programmatic (implementing organization, funding and schedule) requirements for the development and operation of the mission, including the baseline and threshold science requirements.

Statement in *Level 1 Requirements* document:

“Science implies research, applied research, and applications for the purposes of this requirements document.”

The Level 1 documents also clearly define the data product latency requirements for the missions.
Future Missions timeline

LDCM
GPM Core
SAGE-III*
OCO-2
SMAP
ICESAT-II
GRACE-FO
OCO-3*
SWOT*
PACE*
DESDynl
ASCENDS*
CLARREO-1
Venture (Instruments)
Venture (Small-Sat)

Launch
*Instrument for flight on the ISS
*Instrument-only for MOO
*Launch order to be determined

Near-Term Systematic Missions (3/2012)

- **LDCM**: 1/2013 w/ USGS; TIRS
- **GPM**: 2/2014 w/ JAXA; Precip
- **OCO-2**: 2014 Global CO₂
- **GRACE-FO**: 2017 w/ DLR, GFZ (Germany) Gravity, Ice, Grd. Water, Climate
- **ICESat-II**: January 2016 Ice Dynamics
- **SAGE-III on ISS**: August 2014 w/ HEOMD, ESA Atmos. Profiles
- **SMAP**: October 2014 w/ CSA Soil Moist., Frz/Thaw
National Earth Observation Strategy
**NEO Task Force and AWG Timelines**

### CY 2011
- **JAN**: NEO Task Force Meeting
- **MAY**: 1st Draft of Strategy Completed
- **JUL**: Initial TF Member Review
- **SEP**: 2nd Draft of Strategy Released
- **OCT**: Reviews Completed
- **NOV**: OSTP: Publication of Strategy
- **DEC**: Assessment Working Group Kickoff

### CY 2012
- **JAN**: SBA Workshop
- **FEB**: Preliminary List of Obs Systems to OSTP
- **MAR**: Draft National Assessment Delivered

### CY 2013
- **APR**: Assessment Working Group terminates
- **MAY**: OSTP develops National Plan for Earth Observations
- **JUN**: Plan published as FY14 budget supplement

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* Full Academy Review and Stakeholder Forums to follow
Assessment Working Group Deliverable

From the Strategy:

“A time-phased, prioritized national portfolio of Earth observation systems, networks, and platforms to be developed, deployed, maintained, updated, and rebalanced every 3 years over the 10-year planning horizon.”

What to deliver:

• National Observing System Portfolio (current)
• Baseline assessment of current portfolio, tiered by relative criticality
  – Both individual SBAs and an overall NEO integrated assessment
• Optimized 10-Year National Observing System Portfolio
  – Recommended portfolio (current, planned, and new capabilities required) tiered by relative criticality over 10-year planning horizon.
  Both individual SBAs and an overall NEO portfolio
Suomi NPP provides critical data continuity for Earth science research and risk reduction for JPSS instruments, algorithms, ground system, and archive.

Suomi NPP will continue essential climate, weather, and environmental data from polar orbit:

<table>
<thead>
<tr>
<th>NASA</th>
<th>NOAA</th>
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<tbody>
<tr>
<td>AIRS (\rightarrow) CrIS</td>
<td>HIRS (\rightarrow) CrIS</td>
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<tr>
<td>AMSU (\rightarrow) ATMS</td>
<td>AMSU (\rightarrow) ATMS</td>
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<tr>
<td>MODIS (\rightarrow) VIIRS</td>
<td>AVHRR (\rightarrow) VIIRS</td>
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<td>OMI (\rightarrow) OMPS</td>
<td>SBUV2 (\rightarrow) OMPS</td>
</tr>
<tr>
<td>CERES (\rightarrow) CERES</td>
<td>CERES (\rightarrow) CERES</td>
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</tbody>
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**Anticipated Benefits**
- Tracking Climate Changes – *measurements to understand climate and the health of our planet*
- A Vigilant Eye on Ozone – *daily measurements to assess recovery of the ozone layer*
- A Sentinel When Disaster Strikes – *wildfires, volcanic eruptions, snowstorms, droughts, floods, hurricanes*
- Watching the Weather – *soundings of atmospheric temperature and moisture, cloud cover*

**Suomi NPP Instruments**
- Visible Infrared Imaging Radiometer Suite (VIIRS)
- Cross-track Infrared Sounder (CrIS)
- Advanced Technology Microwave Sounder (ATMS)
- Ozone Mapping and Profiler Suite (OMPS)
- Clouds and the Earth's Radiant Energy System (CERES)

→ Only CERES has flown in space before, the four other instruments are new designs.

**Suomi NPP** involves a joint effort of NASA, NOAA, and DOD.

Launched: October 28, 2011
NASA Earth Science Division is sponsoring an applications workshop for the *Suomi NPP* satellite mission.

Workshop is June 21-22, 2012. Location: Westin DC City Center Hotel, Washington DC.

Workshop to familiarize the applications community with the mission and with information on acquisition and use of the data.

1) Update attendees on *Suomi NPP* including instrument performance, data characteristics, access to data and data products;

2) Review applications of data from all *Suomi NPP* instruments, with emphasis on VIIRS; and,

3) Provide information on opportunities for community feedback to *Suomi NPP* team on data products, data access, and other user needs.
Public and private organizations routinely and seamlessly integrate Earth observations in their decision making activities and demand additional observation types and Earth science knowledge.
Contact Info:

Lawrence Friedl
Director, NASA Applied Sciences Program
202.358.7200
LFriedl@NASA.gov
NASA Headquarters • Washington, DC
Questions

http://AppliedSciences.NASA.gov
Back-up Materials
SMD/ESD Applied Sciences Program
Organization Chart (Feb. 2012)

Lawrence Friedl
Director

E. Lucien Cox
Operations Manager

Cassandra Nuñez*
AAAS Fellow

Kathy Carroll*
Office Manager

Sarah Burgess-Herbert*
Special Studies

John Haynes
Health & AQ

Frank Lindsay
Disasters

Woody Turner
Ecological Forecasting

Brad Doorn
Water Resources

Nancy Searby
Capacity Building

Andrea Martin*
Communications

Ali Omar
Associate

John Murray
Associate

Jay Skiles
Associate

Karen Mohr
Associate

Dan Irwin
SERVIR

Sue Estes*
Associate

Gary Geller
Associate

Forrest Melton*
Associate

Michael Ruiz
DEVELOP

Maury Estes*
Associate

* IPA or Contractor; F.Lindsay and N.Searby on Detail

E. Lucien Cox on Detail
Planned Earth Science Missions (2011-2022)
Health:
Infectious Disease
Where malaria is not adequately controlled, the seasonality of climate greatly influences the seasonality of malaria transmission.

**Factors**
Which play important role in the breeding sites for the mosquito vector (Anopheline species)?

Which regulate the development rate of both the mosquito larvae and the malaria parasite within the mosquito host?

Which play an important role in the survival and longevity of the mosquito vector?

---

Seasonal Climatological Suitability for Malaria Transmission

Number of months during year suitable for malaria transmission, based on monthly climatological averages.

Climate Suitability ≡ $18-32^\circ C + 80\text{mm} + \text{RH}>60\%$

These are rough thresholds that are intended to describe conditions that are suitable for both the development of the parasite and the life cycle of the mosquito vector.

Note: Masked to exclude malaria-absent or endemic areas.

Malaria Early Warning System

Rainfall largely responsible for creating conditions allowing sufficient surface water for mosquito breeding. Explosive epidemics often occur in these regions after excessive rains.

MEWS interface provides a contextual perspective of recent precipitation

Precipitation analysis by merging gauge obs. and 3 kinds of satellite sensor estimates (GPI, SSM/I, and AMSU).

Map shows ~10-day est. precip.

http://iridl.ldeo.columbia.edu/maproom/Health/Regional/Africa/Malaria/MEWS/