Bringing Space Technology to Precision Ag

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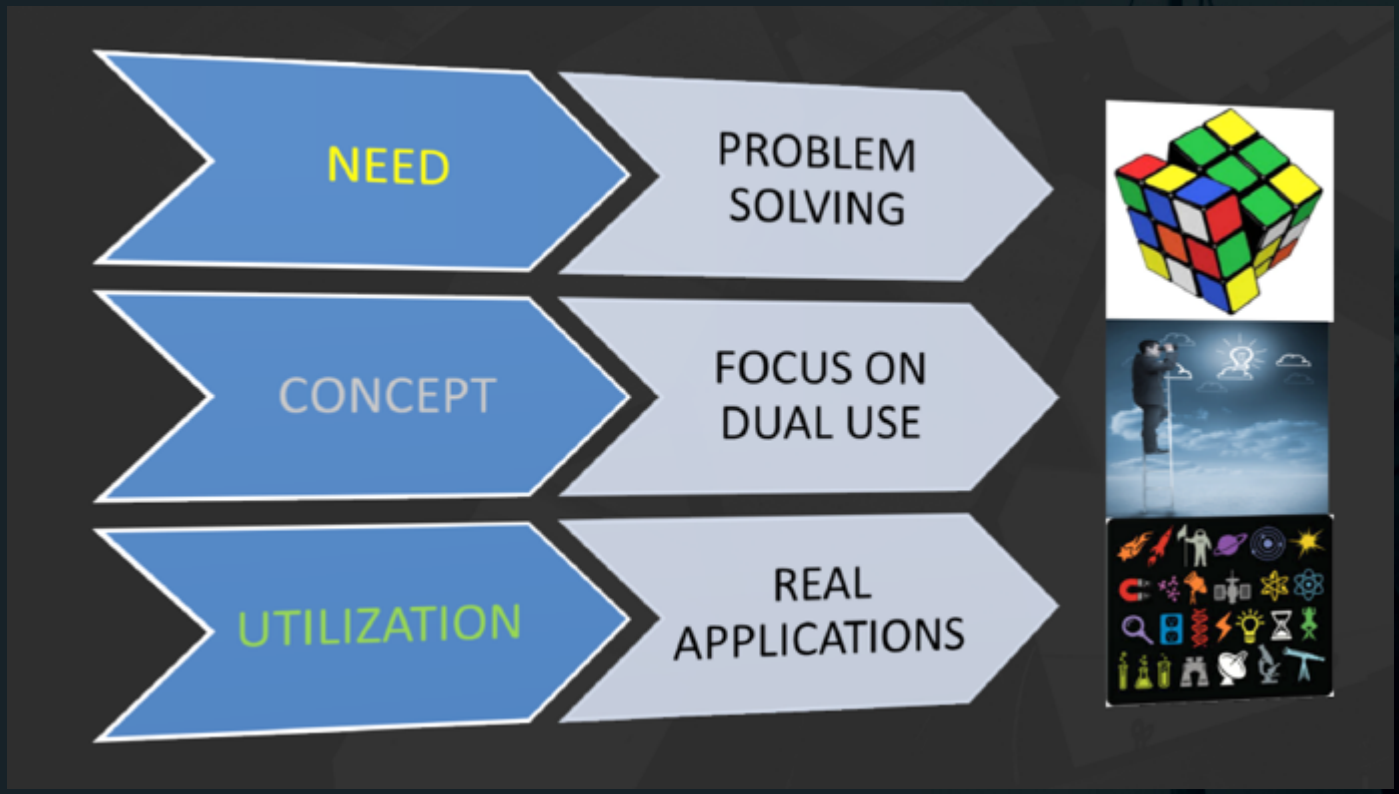
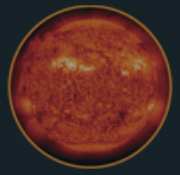
NASA Goddard SPACE FLIGHT CENTER
www.nasa.gov/goddard

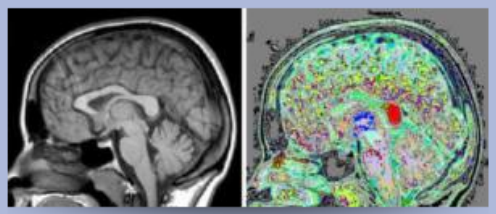
NASA is the Only Agency with Technology Transfer a Mission in its Enabling Legislation



You See Our Technology Every Day

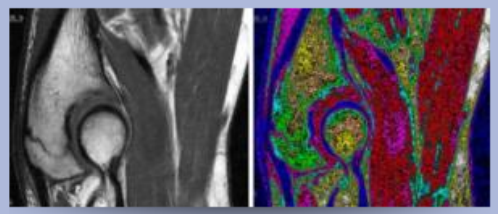


And Places You Would Not Expect



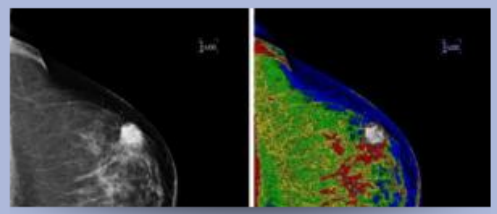
MED-SEG™ Sagittal Brain MRI

Original sagittal view of the brain is on the left and one segmented view is on the right. Processed image is from an MRI.



MED-SEG™ Sagittal Elbow MRI

Original sagittal view of the elbow is on the left and one segmented view is on the right. Processed image is from an MRI

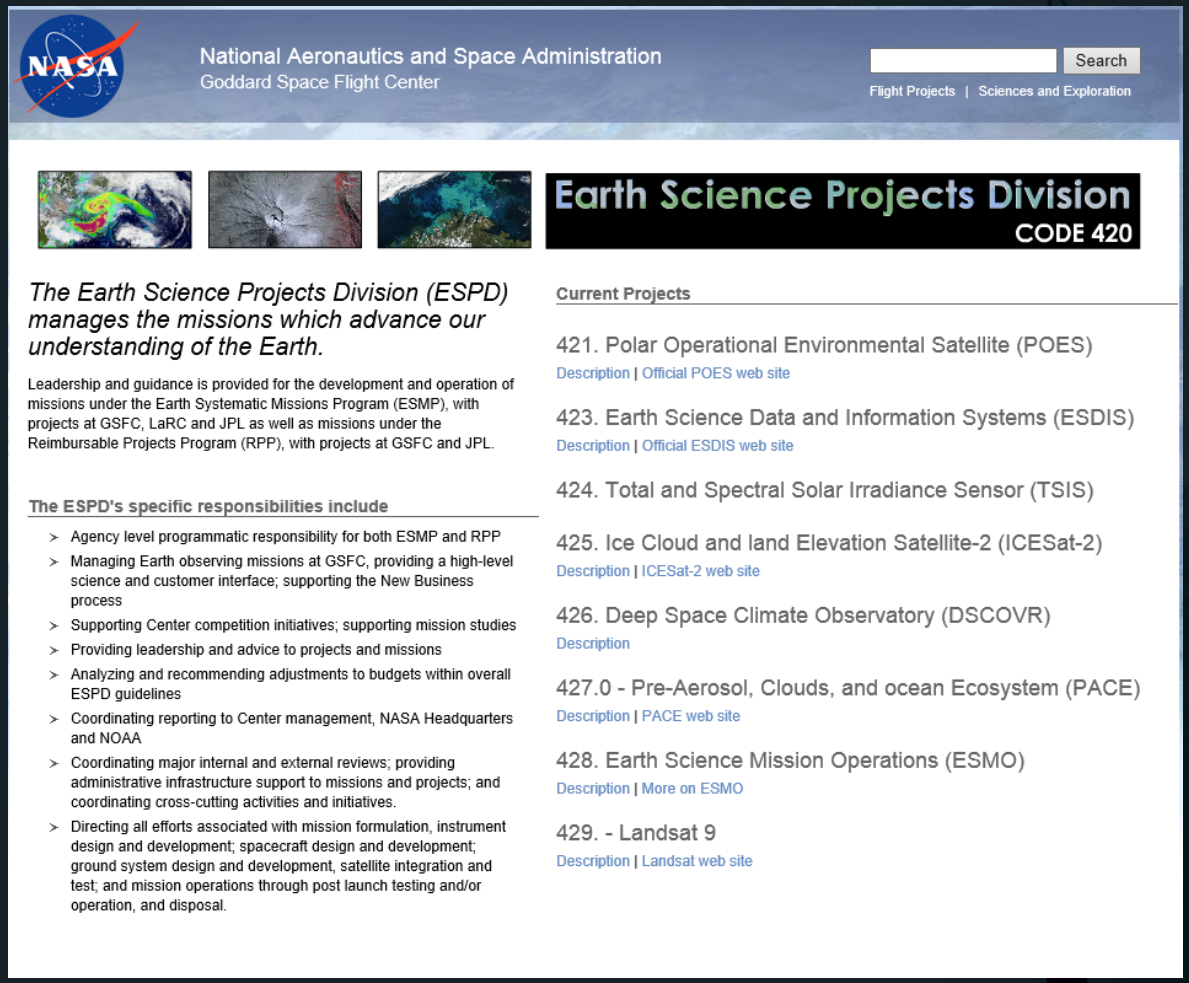


MED-SEG™ Breast X-ray (Mammogram)

Original mammogram is on the left and one segmented view with ROI is on the right

IR&D 100 Winner

Missions Drive our Technology



National Aeronautics and Space Administration
Goddard Space Flight Center

Search

Flight Projects | Sciences and Exploration

Earth Science Projects Division
CODE 420

The Earth Science Projects Division (ESPD) manages the missions which advance our understanding of the Earth.

Leadership and guidance is provided for the development and operation of missions under the Earth Systematic Missions Program (ESMP), with projects at GSFC, LaRC and JPL as well as missions under the Reimbursable Projects Program (RPP), with projects at GSFC and JPL.

The ESPD's specific responsibilities include

- Agency level programmatic responsibility for both ESMP and RPP
- Managing Earth observing missions at GSFC, providing a high-level science and customer interface; supporting the New Business process
- Supporting Center competition initiatives; supporting mission studies
- Providing leadership and advice to projects and missions
- Analyzing and recommending adjustments to budgets within overall ESPD guidelines
- Coordinating reporting to Center management, NASA Headquarters and NOAA
- Coordinating major internal and external reviews; providing administrative infrastructure support to missions and projects; and coordinating cross-cutting activities and initiatives.
- Directing all efforts associated with mission formulation, instrument design and development; spacecraft design and development; ground system design and development, satellite integration and test; and mission operations through post launch testing and/or operation, and disposal.

Current Projects

421. Polar Operational Environmental Satellite (POES)
Description | Official POES web site

423. Earth Science Data and Information Systems (ESDIS)
Description | Official ESDIS web site

424. Total and Spectral Solar Irradiance Sensor (TSIS)

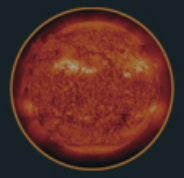
425. Ice Cloud and land Elevation Satellite-2 (ICESat-2)
Description | ICESat-2 web site

426. Deep Space Climate Observatory (DSCOVR)
Description

427.0 - Pre-Aerosol, Clouds, and ocean Ecosystem (PACE)
Description | PACE web site

428. Earth Science Mission Operations (ESMO)
Description | More on ESMO

429. - Landsat 9
Description | Landsat web site

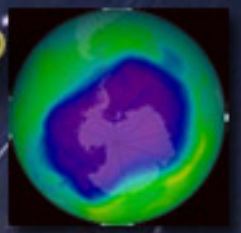


NASA Goddard SPACE FLIGHT CENTER

What Does Goddard Do?

Earth's Shrinking Ice

Amazing Spacecraft

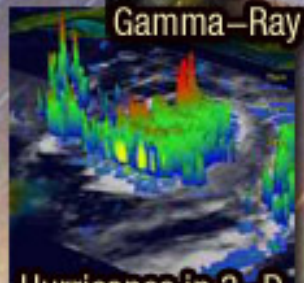

The Ozone Hole

Gamma–Ray Bursts

Climate Change

The Moon

Black Holes

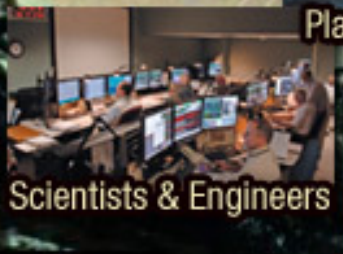

Hurricanes in 3–D

Solar Flares

Planets & Exoplanets

Comets

Pulsars


Scientists & Engineers

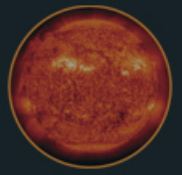
Rockets & Balloons

Groundbreaking Technologies

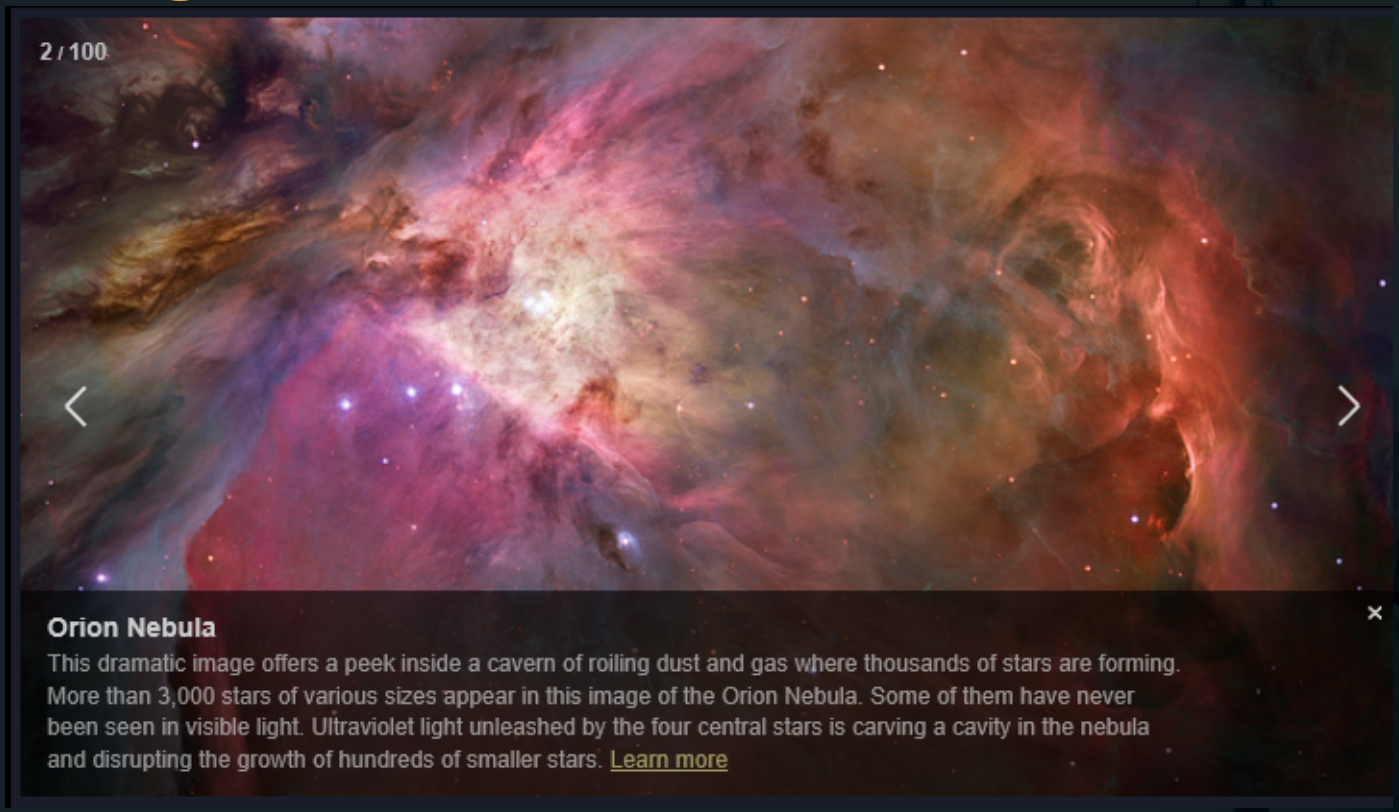
Movies & Podcasts

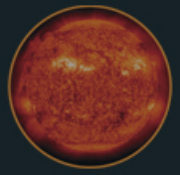
Tours & Exhibits

Clean Rooms & Laboratories



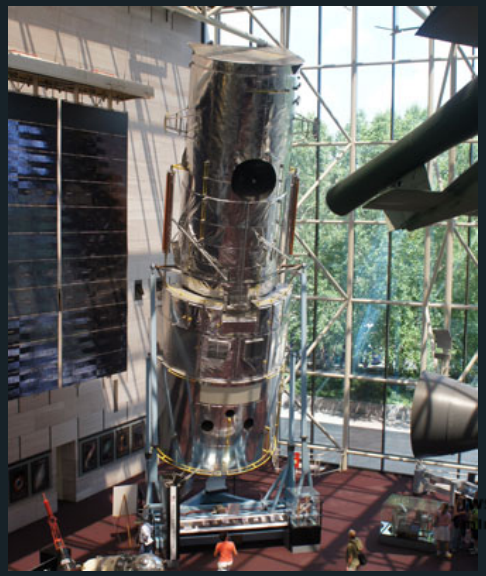
Corrective Optics and Software for Waveforms and Distortion – Seeing through Dust





Aside – New Mission Means New Technology

Hubble



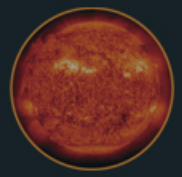
James Webb

Space Mission Technical Challenges Mean Opportunities for You

Hardware & Coatings

- "Small"
- Lightweight
- Robust – Harsh Environments
- Reliable
- Sensor Laden/Data Collection Packages

Lift Vehicles and Platforms



- Rockets, Aircraft, Drones, Balloons, Kites
- Satellites, CubeSats, Stabilizing Platform

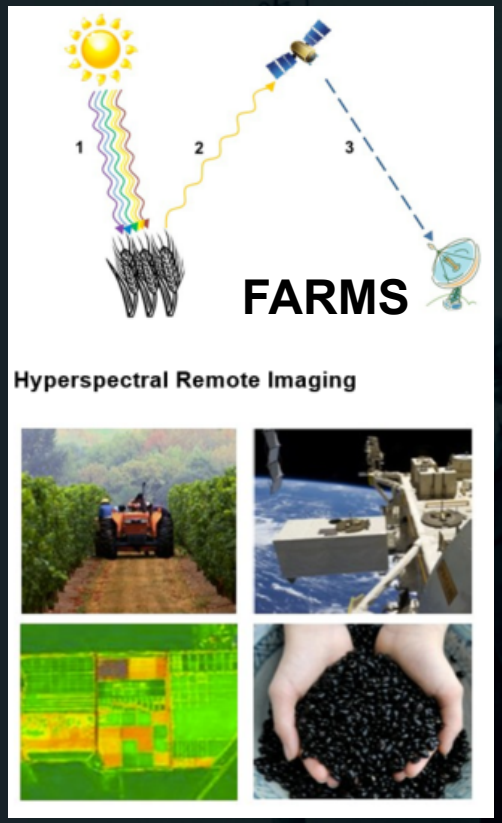
Sensors

- Optical – Visible, UV, IR
- Chemical

Software

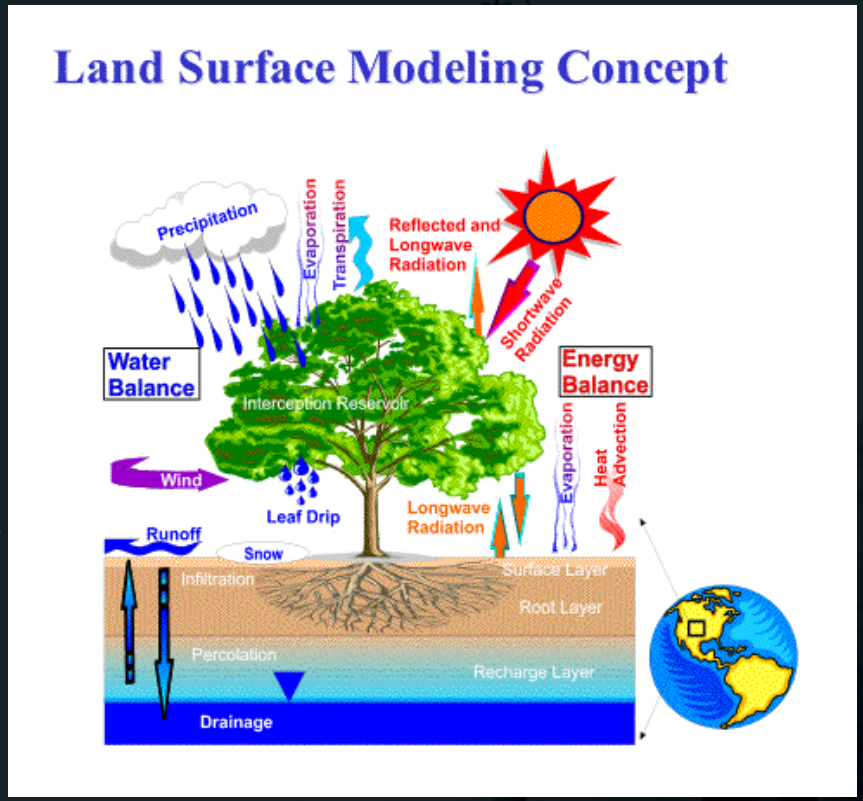
- Space - Use
  - Limited On-Board Processing and Storage
  - Narrow Bandwidth Communications, often with Delays, High Compression
  - Navigation, Control, Collision Avoidance, Swarms Coordination
  - Remote Repair and Maintenance
  - Interoperability/Plug & Play/Upgrades
- Ground – Ground Use
  - From Small to Massive Transmission, Processing and Storage
  - Option of High Bandwidth Availability
  - Widespread use of Simulation
  - Emphasis on Visualization

Free and Easy Access to over 400 Climate Data Variables for Any Location on the Earth



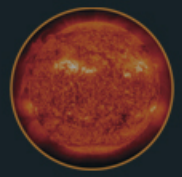
Land Information System: Water and Precipitation Measurement and Forecast

- Community sharing of modeling tools, data resources, and assimilation algorithms.
- Decision Support System for water resources mgt., agriculture, numerical weather prediction, etc.
- Integrates observations with the model forecasts to generate improved estimates of land surface conditions such as soil moisture, evaporation, snow pack, and runoff, at 1km and finer spatial resolutions and at one-hour and finer temporal resolutions.



The NASA Software Catalog is Found at https://software.nasa.gov/

Much of Our Software is Open Source



Invasive Species Forecasting System (ISFS) Applications/QuickMap

QuickMap is a simple OS X drag-and-drop application that automates an ISFS model run. Input consists of presence/absence point location data in the form of a text file. Output includes a diagnostic report that provides statistical details about the model and its resulting predictive surface.

U.S. Release Only

Invasive Species Forecasting System (ISFS) Architecture and Operation

This technology supports the ISFS canonical modeling workflow, a set of sequential atomic steps necessary for computing a predictive spatial model.

U.S. Release Only

Invasive Species Forecasting System (ISFS) Command Interpreter (iShell)

This iShell technology is a command interpreter and script host that provides a traditional user interface to ISFS Core Services for UNIX and UNIX-like systems.

U.S. Release Only

Invasive Species Forecasting System (ISFS) Core Services (iCore)

These file-conversion programs implement the ISFS canonical modeling workflow.

U.S. Release Only

Invasive Species Forecasting System (ISFS) Framework

These programs, data, utilities, and documentation are required to create and run tailored site- and user-specific ISFS applications. By providing a skeleton for the software components common to all ISFS tools, the technology enables developers to build customized applications more quickly and...

U.S. Release Only

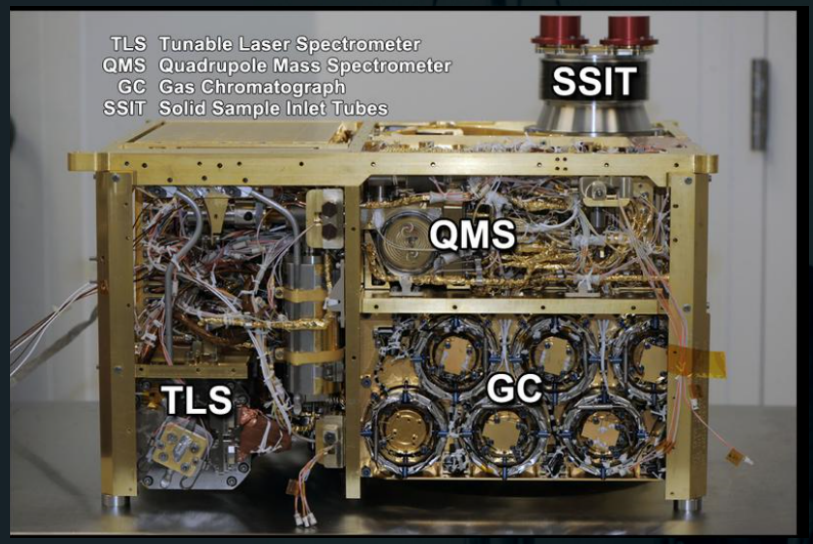
Invasive Species Forecasting System (ISFS) Predictors/GSENM

ISFS Predictors are site-specific environmental, remote sensing, and related data sets used as independent, covariate predictor variables in ISFS model runs.

U.S. Release Only

Our Technology Can be Repurposed for Precision Ag

- Optical and Other Sensors
  - Innovative Sensors (One Atom Thick Graphene)
  - Calibration Facilities and Tools
  - Wavefront and Distortion (e.g. dust) Correction Hardware and Software
- Atmosphere, Rock, and Soil Analytical Devices
  - Chemical Composition
  - Microwave Oven Sized
  - Solar Powered

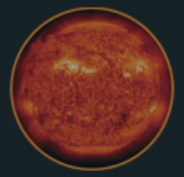


On Mars

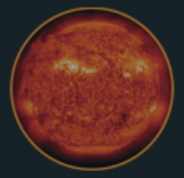
It is "Mission Ready" but Not Commercially Ready

Vehicles for Working with NASA

Program	How Working with the ITPO Benefits External Partners
Technology Transfer	• License technology from NASA (rather than developing your own or paying more elsewhere) to provide selected technology solutions.
SBIR / STTR	• Receive funding to help meet NASA's R&D challenges which (a) oftentimes matches your own development goals and/or (b) creates new business opportunities (which could include NASA as a customer)
Partnerships	• Collaborate to develop technology that is of benefit to both NASA and you (increasing development speed and/or decreasing development investment).



MERRA Customizations



National Aeronautics and Space Administration
Goddard Space Flight Center

GO

Earth Sciences Division | Sciences and Exploration

Global Modeling and Assimilation Office

Home

Research | GEOS | Products | Projects | Seminars | Publications

- *MERRA INFORMATION PAGES*
- MERRA Brochure [PDF]
- Introduction
- MERRA Atlas
- MERRA-Land
- MERRA Input Catalog
- OpenGrADS Tools
- FAQ
- MERRA Discussion (blog)
- Publications
- Presentations
- System Information
- File Specification Documents
- External Users Group
- MERRA News Archive

Other Links

- MERRA-Relevant Links
- Reanalysis Intercomparison and Observations
- 4th WCRP Int'l Conf. on Reanalysis (See Conf. report)
- 3rd WCRP Int'l Conf. on Reanalysis
- Contact Us

MERRA: MODERN-ERA RETROSPECTIVE ANALYSIS FOR RESEARCH AND APPLICATIONS

MERRA is a NASA reanalysis for the satellite era using a major new version of the Goddard Earth Observing System Data Assimilation System Version 5 (GEOS-5). The Project focuses on historical analyses of the hydrological cycle on a broad range of weather and climate time scales and places the NASA EOS suite of observations in a climate context.
[Read More.]

Accessing MERRA

MERRA data are available at the Modeling and AssimilationData and Information Services Center (MDISC), managed by the NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

Sign Up for the MERRA Mailing List

Sign up for the MERRA email list to receive announcements on the latest data information, tools and services that become available, data announcements from GMAO and more! Contact the GES DISC User Services to be added to the list.

MERRA Contacts

Should you still have questions regarding MERRA data or accessibility after reading through the information here and at the MDISC site, please send email to:
merra-questions@lists.nasa.gov.

News and Status

• ICR4 Conference Report Available •

The Report of the 4th International Conference on Reanalyses is available from the World Climate Research Programme at http://www.wcrp-climate.org/documents/ICR4_Report.pdf

• Two new products added to GMAO's extensive suite of MERRA data •

A new ocean surface diagnostics product and a new land surface diagnostics product have been added to the suite of MERRA data available through the GES DISC. Read more about these new data products.

• MERRA File Specification now available •

The MERRA File Specification, version 2.3, and the latest GEOS5 Glossary are now available on the MERRA File Specification Documentation page.

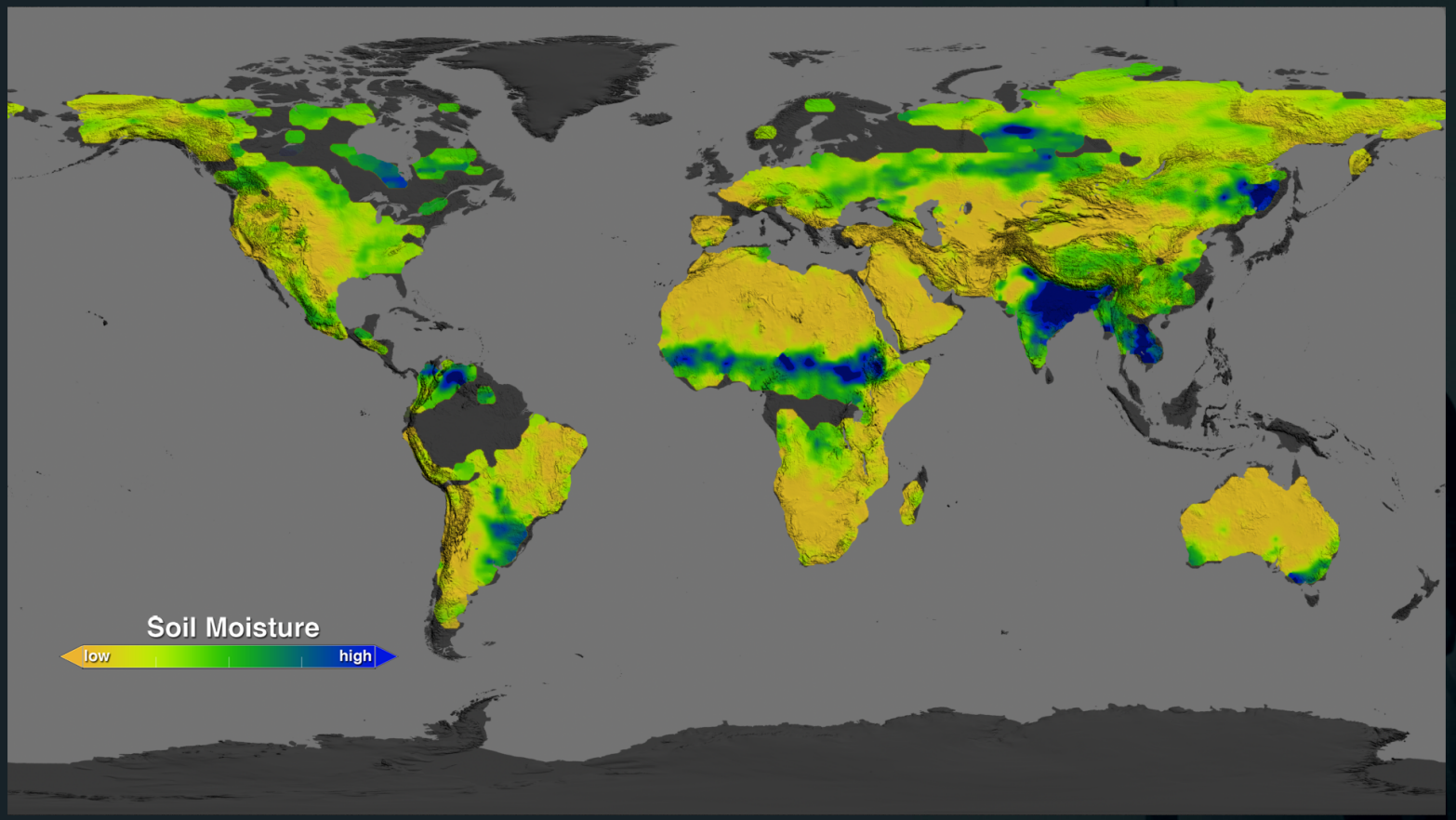
• J. Climate MERRA Special Collection •

Many papers have now been published in the MERRA Special Collection in the AMS Journal of Climate. Others still under review are available on the MERRA publications page.

• MERRA Atlas now available •

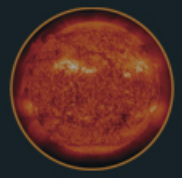
The initial version of the interactive MERRA Atlas is now available online. Please note that the Atlas is still evolving. User comments are invited.

A Visualization Example: Soil Moisture



FARMS – Farmland and Agriculture Remote Measurement Sensor

- **Frequent observations,** especially during the crucial growth periods, providing a better understanding of the following areas, and more:
  - Vegetation structure
  - Environmental forcing function
  - Nutrient status
  - Stress response
  - Water quality and quantity
  - Crop residue quantity and condition
  - Plant respiration and evaporation
- **Precise pointing**, gathering data from specific points of interest;
- **High signal-to-noise ratio**, increasing the confidence and application of the data;
- **High resolution data**, allowing users to derive more accurate conclusions;
- **Global coverage**, reaching areas worldwide to develop more sophisticated models accommodating to a wide variety of ecosystems;
- **Broad spectral range** (380-2400nm), gathering more complete library of information for users worldwide; and
- **Multi-angled images**, distinguishing plant structure.
- **Will fly on Space Station**



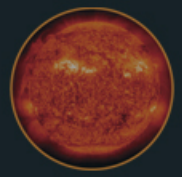
FARMS: Technical Summary

Peak Signal-to-Noise Ratio	1900 – visible 1400 – IR
Spatial Resolution	15 m
Spectral Range	400 – 2400 nm
Spectral Resolution	5 nm @400 nm to 20 nm @ 2400 nm
Coverage	Global, within 51^{0} latitude; up to 1000 locations daily

Seeking Partners Now!

Please Contact Us

- All information you share can be kept confidential.
- We have a variety of vehicle for partnering including Space Act Agreement, Cooperative R&D Agreements, and licensing.
- We can provide exclusive rights for non-governmental use of most patented/ patentable technology.



For more information visit http://itpo.gsfc.nasa.gov/index.html

or contact:

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