NASA OVERVIEW

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NASA – Goddard Space Flight Center
Greenbelt, Maryland
August 11, 2014

NASA has four areas of concentration:

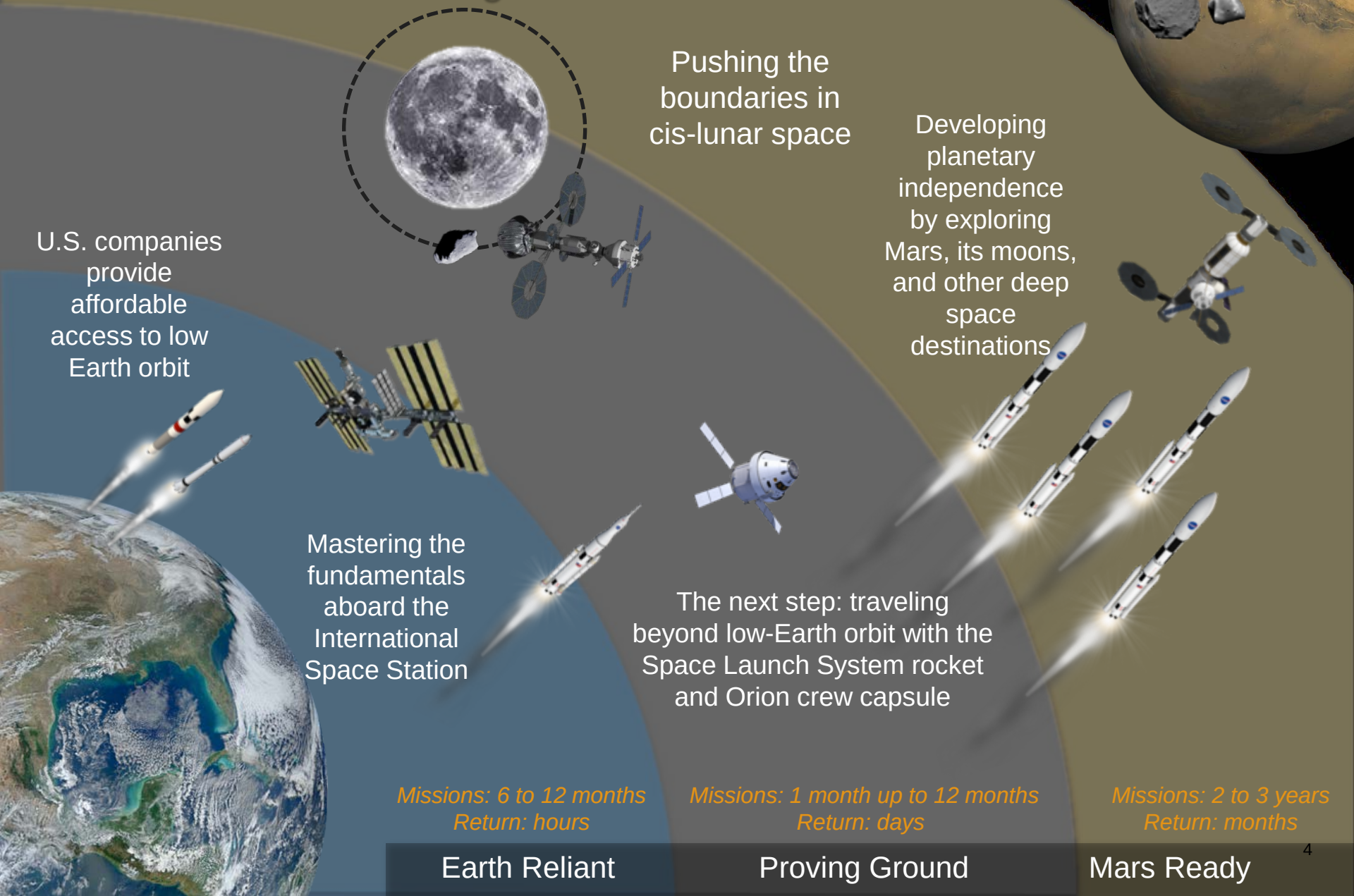
- **Space Exploration**
- **Space Technology**
- **Aeronautics**
- **Science**
  - **Earth Science**

Discontinued

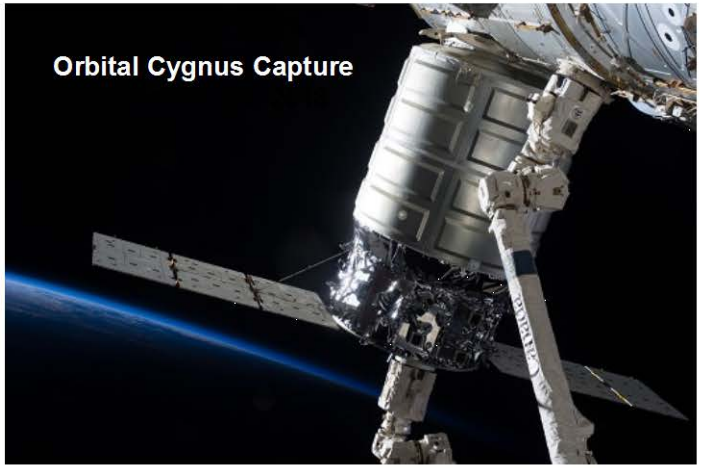
In operation

The Future of Human Space Exploration

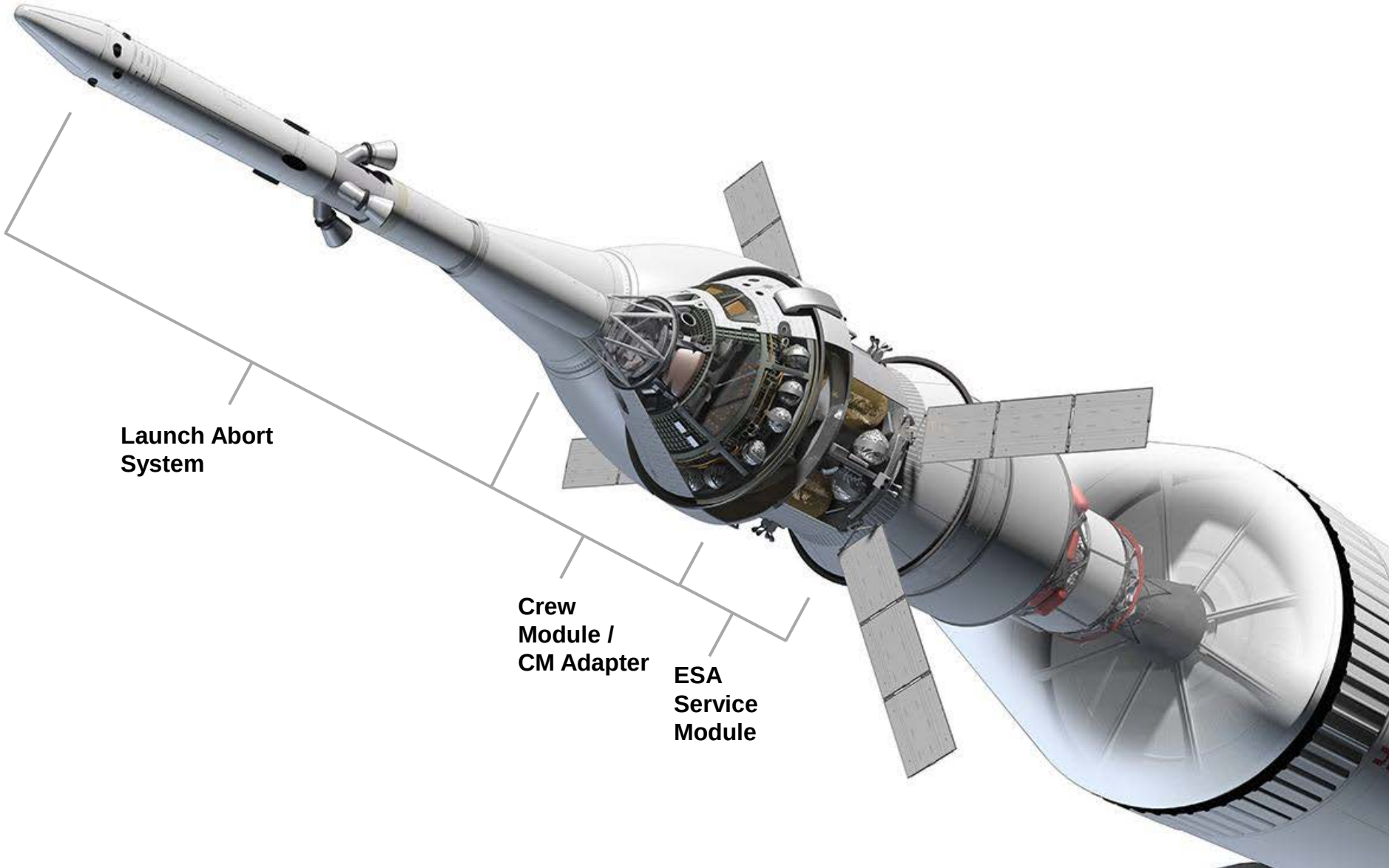
NASA's Building Blocks to Mars



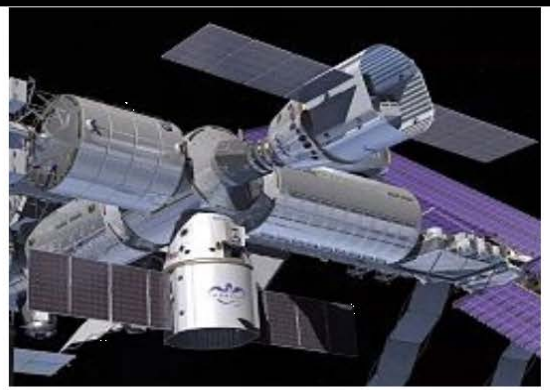
Now Acquiring ISS Cargo Services Commercially!



America's New Rocket: Space Launch System


Launch Abort System
Crew Module / CM Adapter
ESA Service Module

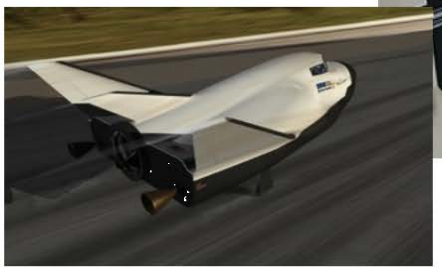
Commercial Crew Partners



Boeing

Sierra Nevada

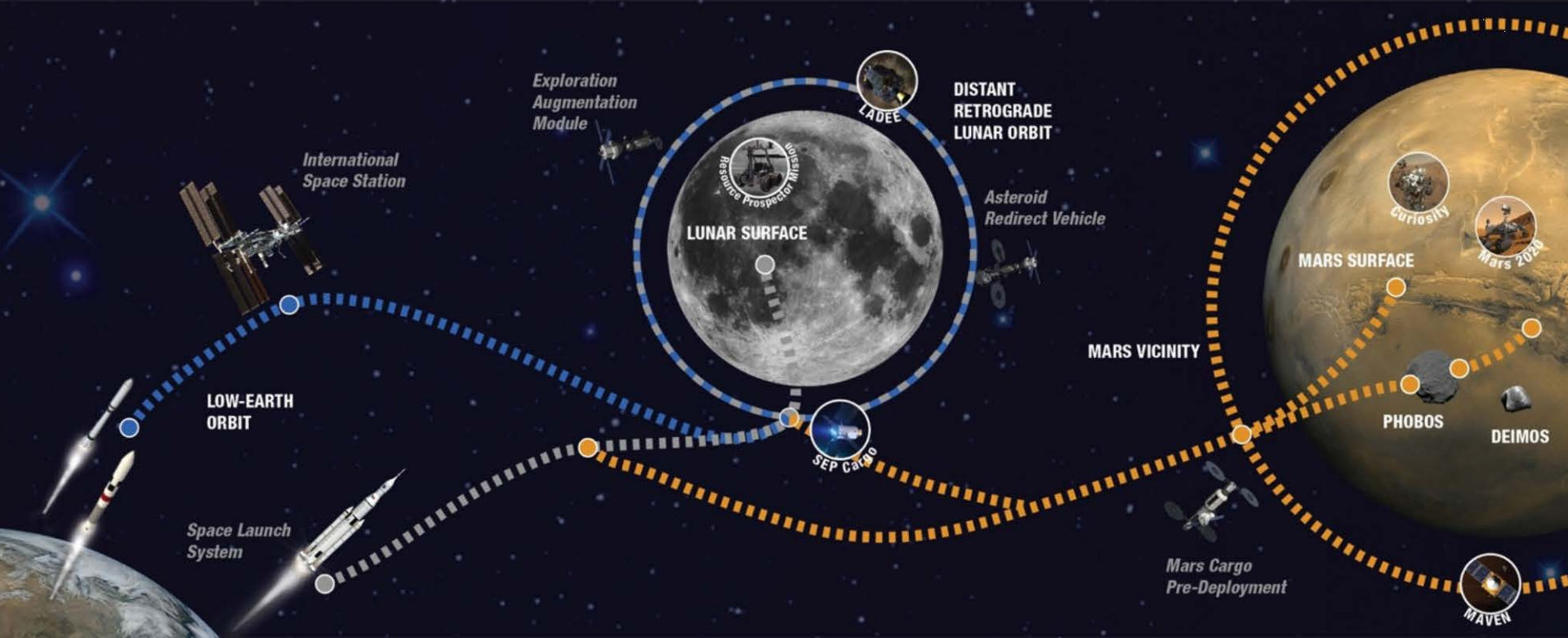
SpaceX



EVOLVABLE MARS CAMPAIGN

A Pathways Approach to Exploration

EARTH DEPENDENT | **PROVING GROUND** | **EARTH INDEPENDENT**



THE TRADE SPACE

Across the Board | Solar Electric Propulsion • In-Situ Resource Utilization (ISRU) • Robotic Precursors • Human/Robotic Interactions • Partnership Coordination • Exploration and Science Activities

Cis-lunar Trades
- Deep-space testing and autonomous operations
- Extensibility to Mars
- Mars system staging/refurbishment point and trajectory analyses

Mars Vicinity Trades
- Split versus monolithic habitat
- Cargo pre-deployment
- Mars Phobos/Deimos activities
- Entry descent and landing concepts
- Transportation technologies/trajectory analyses

Asteroid Redirect Mission

Identify

Asteroid Identification:

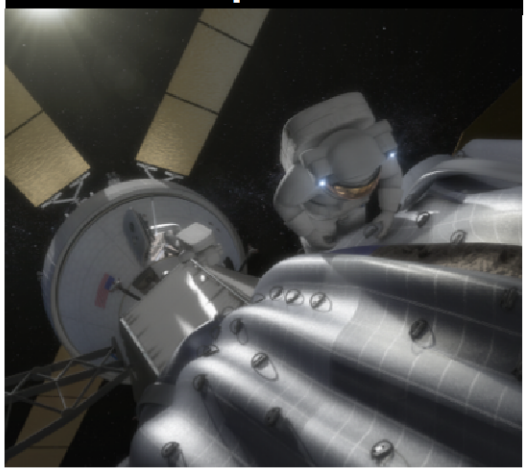
Ground and space based near Earth asteroid (NEA) target detection, characterization and selection

Redirect

Asteroid Redirect Robotic Mission:

High power solar electric propulsion (SEP) based robotic asteroid redirect to lunar distant retrograde orbit

Explore



Asteroid Redirect Crewed Mission:

Orion and Space Launch System based crewed rendezvous and sampling mission to the relocated asteroid

Space Technology Missions

- Technologies for missions beyond low Earth orbit
- More affordable and reliable
- Creating market and innovation

Communication
Environment Control & Life Supporting Systems
Logistics
Power Generation & Storage
Navigation
Entry, Descent & Landing
Radiation Mitigation
Manufacturing In Space & For Space
Propulsion

National Aeronautics and Space Administration

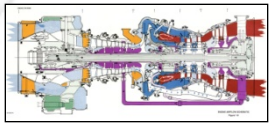
NASA Aeronautics Research

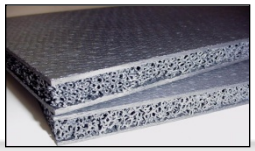
Aeronautics Research Mission

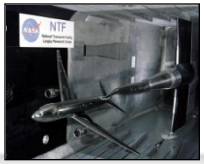
Fundamental Aeronautics

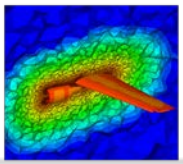
Integrated Systems Research

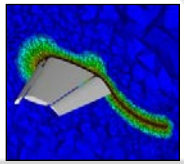
Airspace Systems



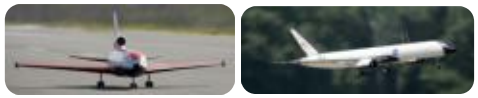






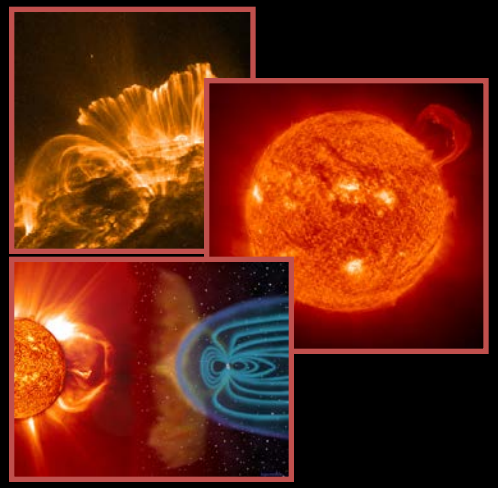


Aviation Safety

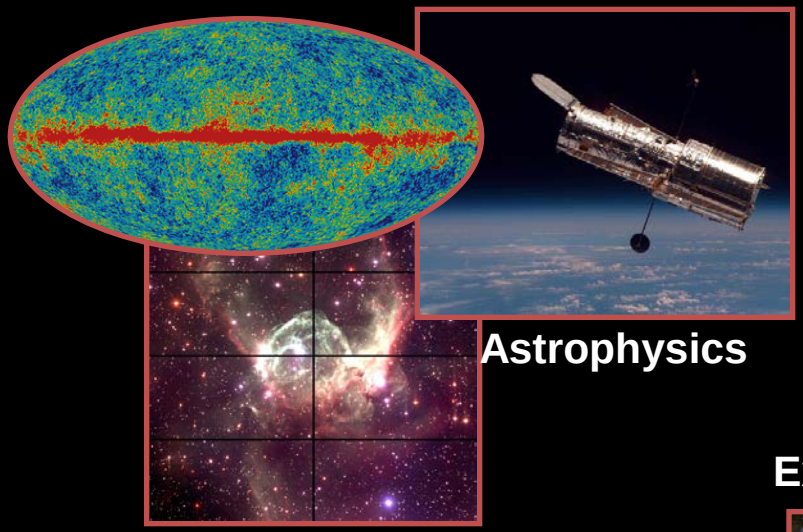


Aeronautics Testing

Science

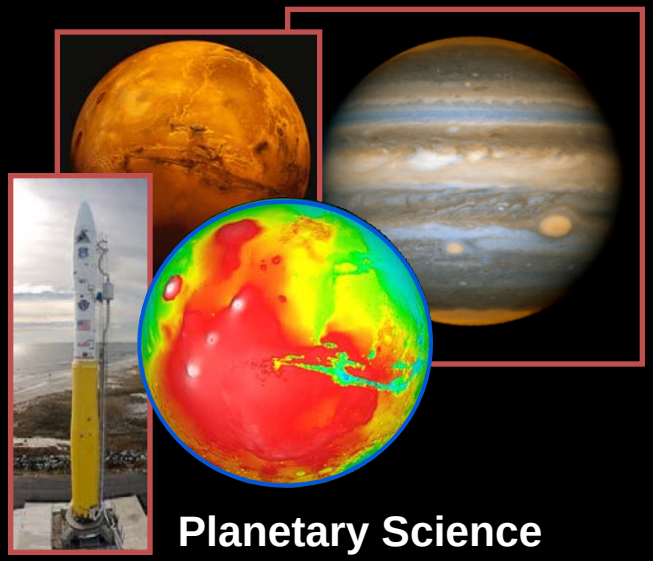


Heliophysics



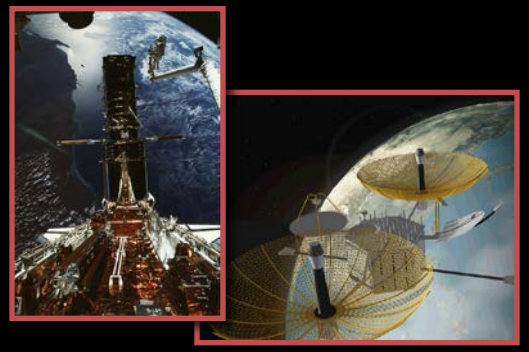
Astrophysics

Exploration Systems



Planetary Science

Earth Science

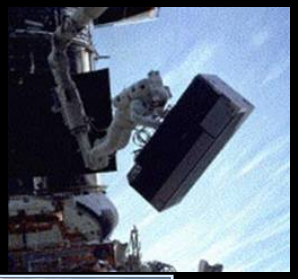


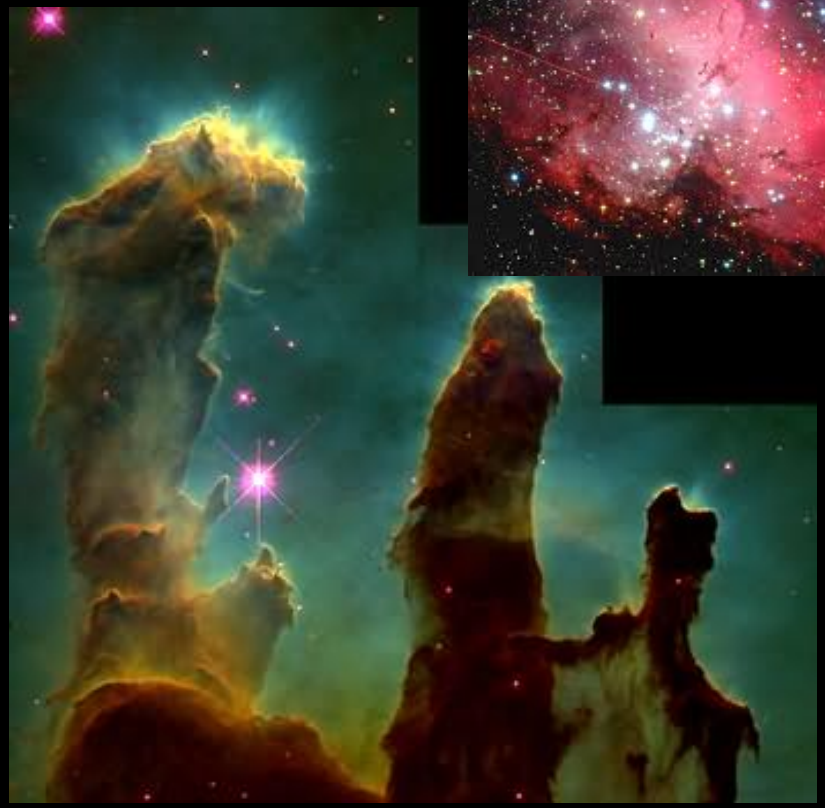
Space Operations

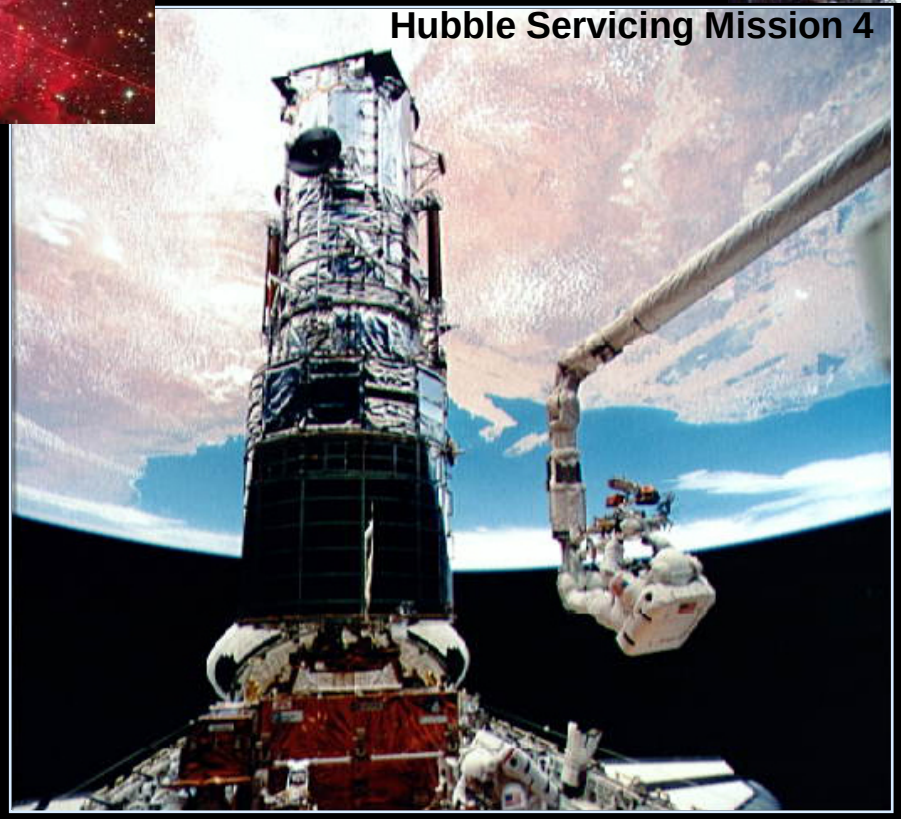
Communications and Navigation

An Amazing 23-Year Legacy of Hubble

M16 Nebula, 6500 light years away from Earth in the Milky Way Galaxy



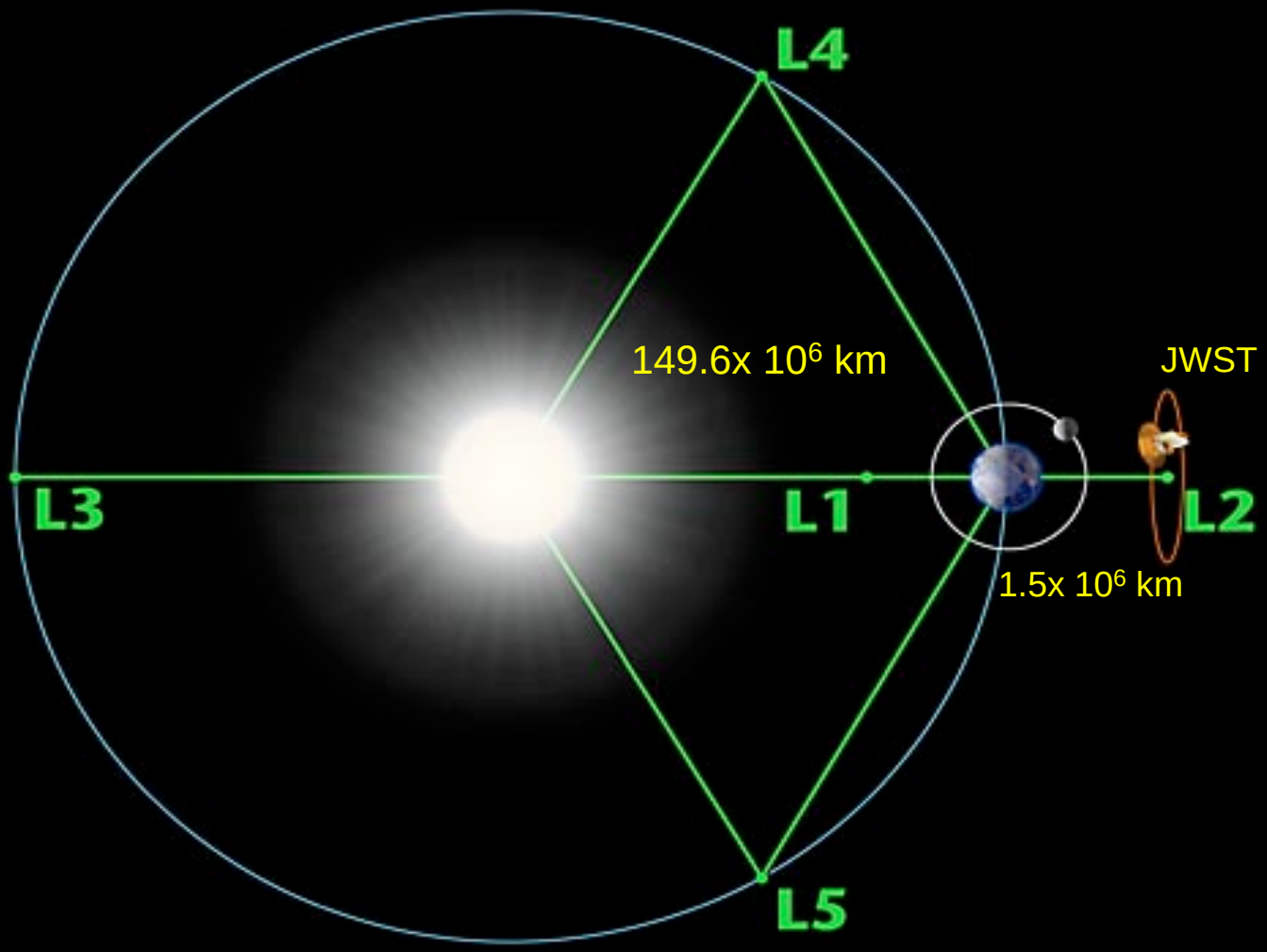




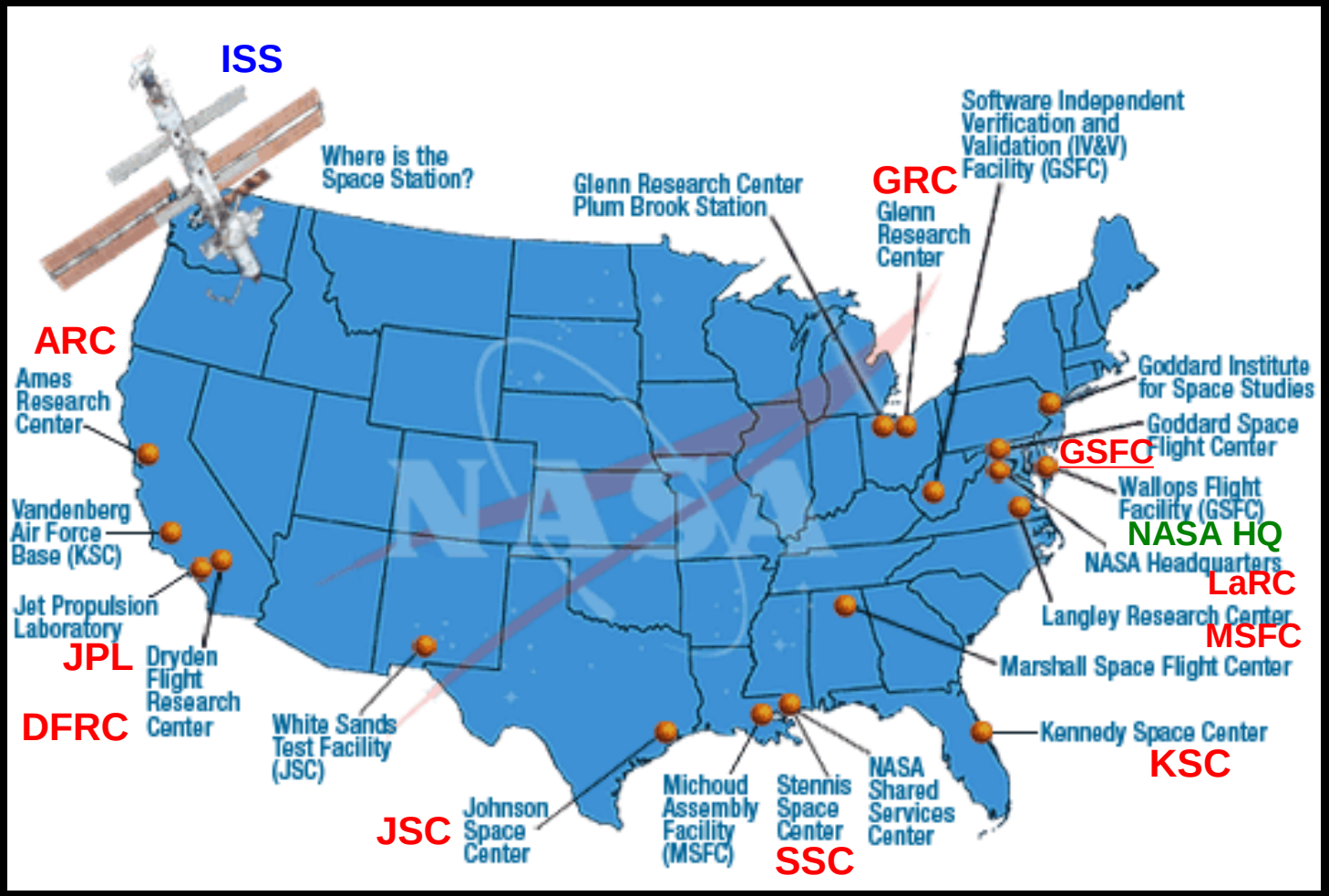
Hubble Servicing Mission 4

- Pillars of Creation: Open cluster of young stars in M16 Nebula
- The tower of gas is 9.5 light years or about 90 trillion (90×10^{12}) kilometers high.

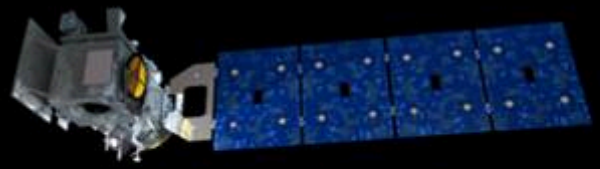
A new frontier in Astrophysics – James Web Space Telescope



NASA Centers



Earth Science



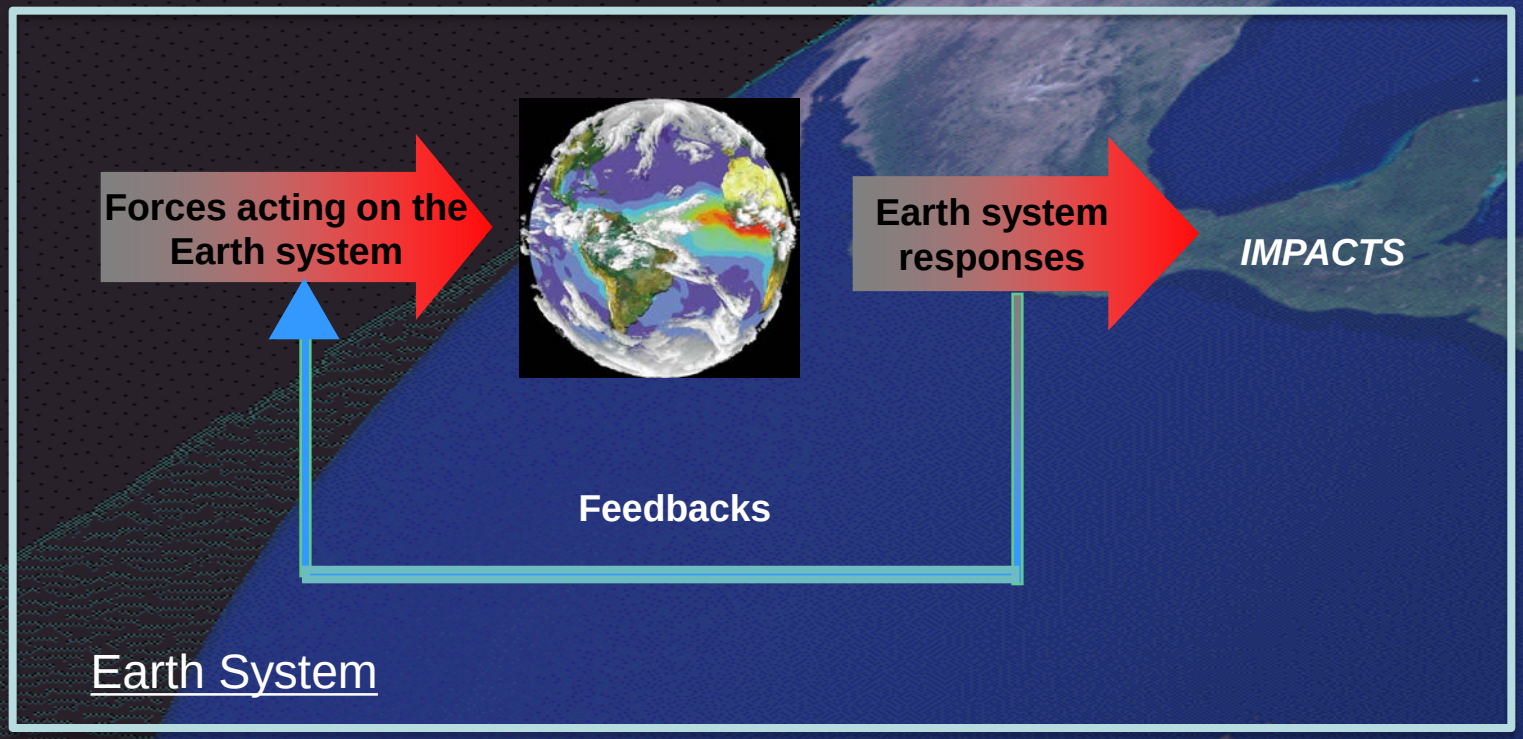
Overarching Questions

How does the Earth work?

How is the Earth changing?

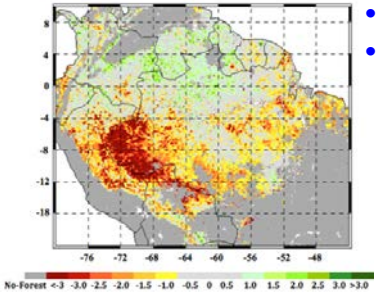
Are human activities altering the chemical composition of the planet

How does our changing environment affect life on Earth?

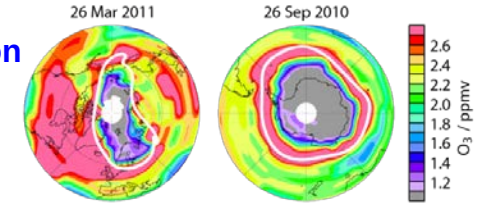


Research Element Focus Areas

- Terrestrial Ecology
- Land Cover/Land Use Change
- Ocean Biogeochemistry
- Biodiversity and Cons. Biology



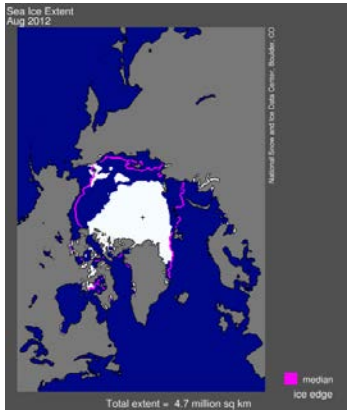
- Atmos. Chemistry Modeling & Analysis
- Atmospheric Composition
- Tropospheric Chemistry
- Atmospheric Radiation



Atmospheric Composition

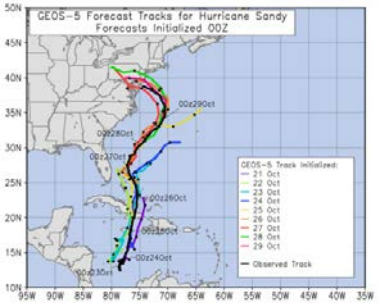
Carbon Cycle and Ecosystems

- Modeling and Prediction
- Cryosphere Science
- Physical Oceanography



Climate Variability and Change

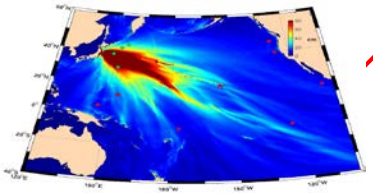
- Global Weather Research
- Operations Transition



Weather

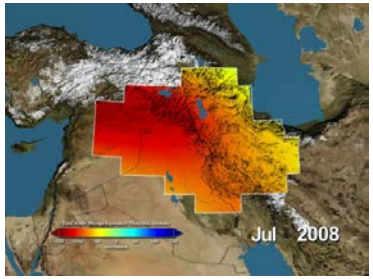
Water and Energy Cycle

Earth Surface and Interior

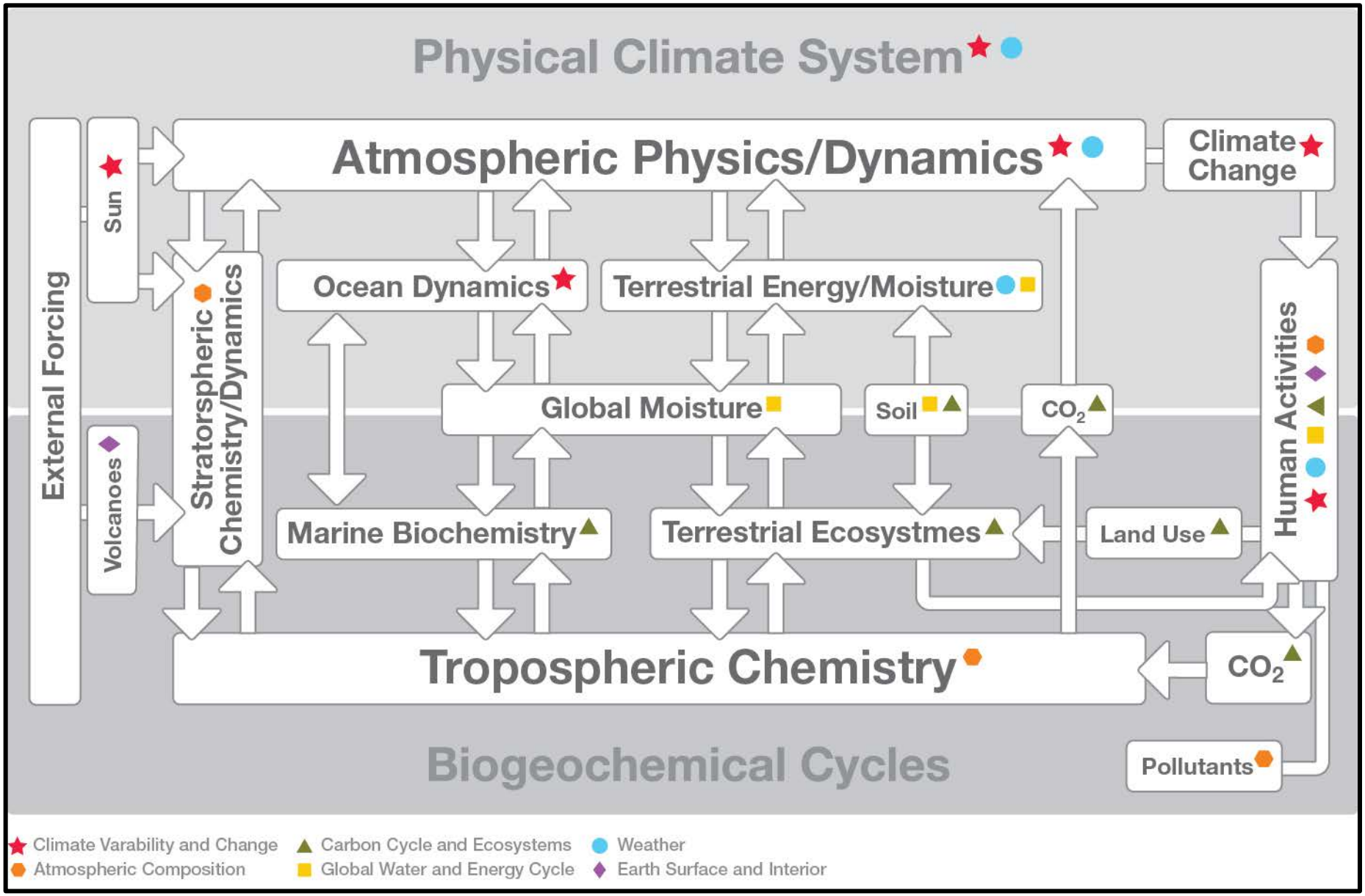


- SE/NH
- Geodetic Imaging

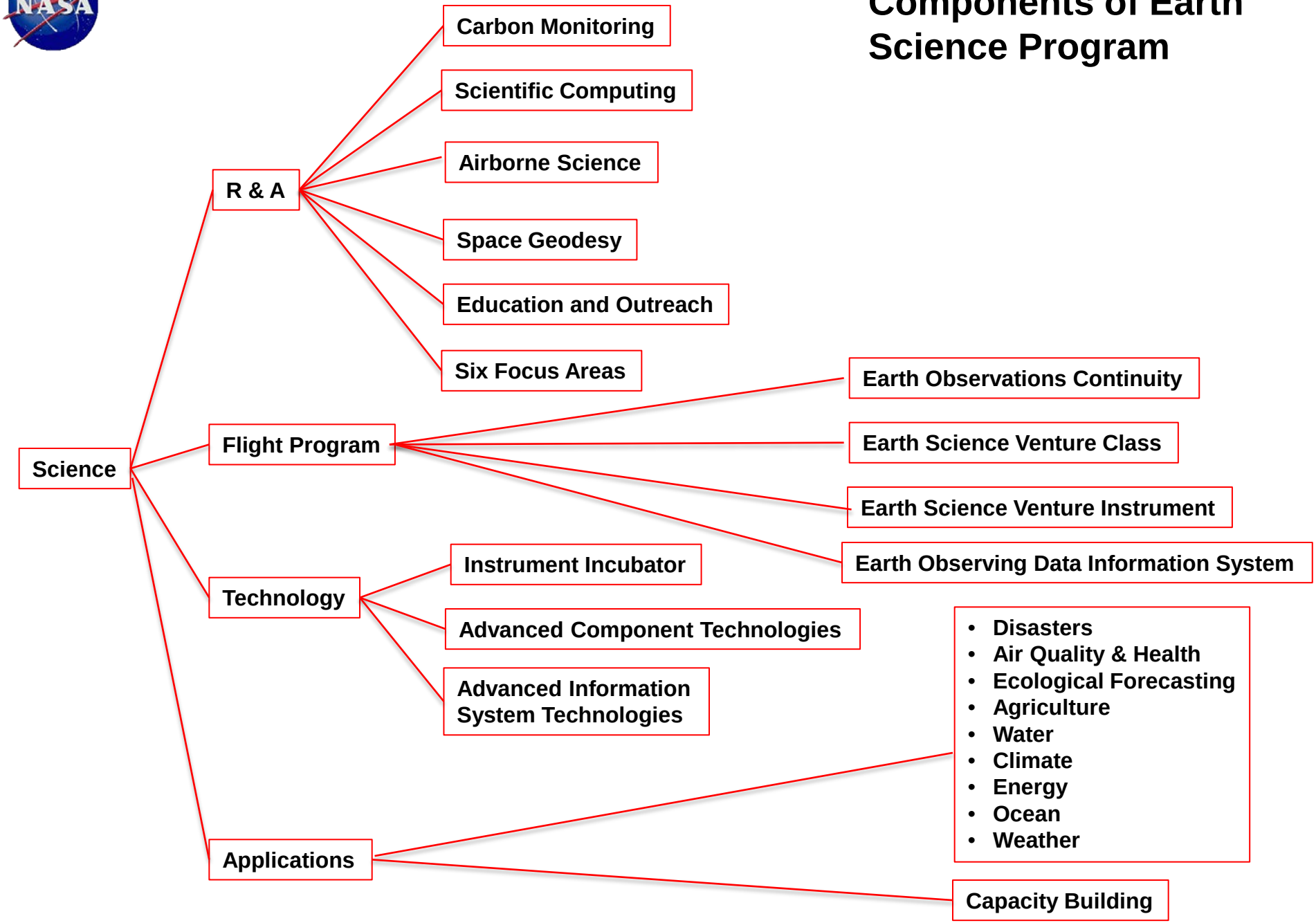
- Atmospheric Dynamics
- Terrestrial Hydrology
- Atmospheric Radiation



Focus Areas Span Earth System Science



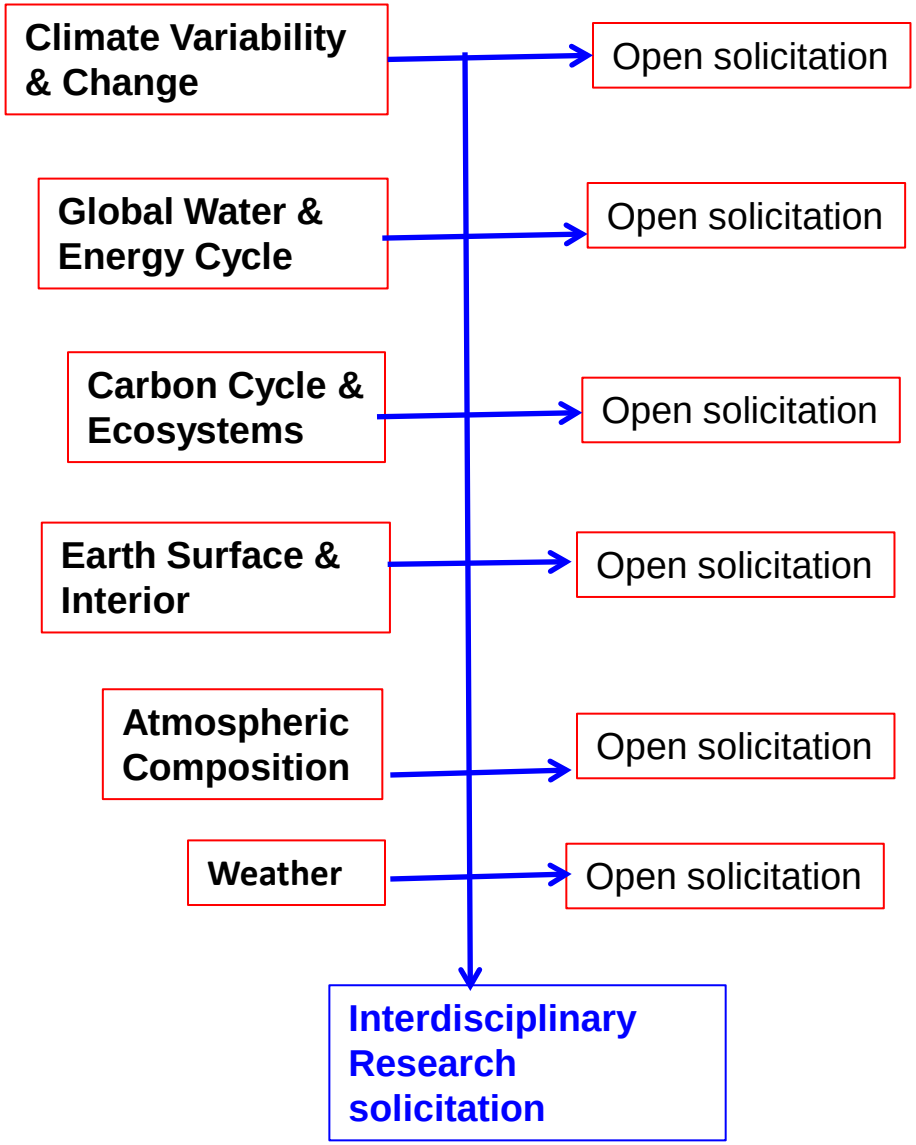
Components of Earth Science Program



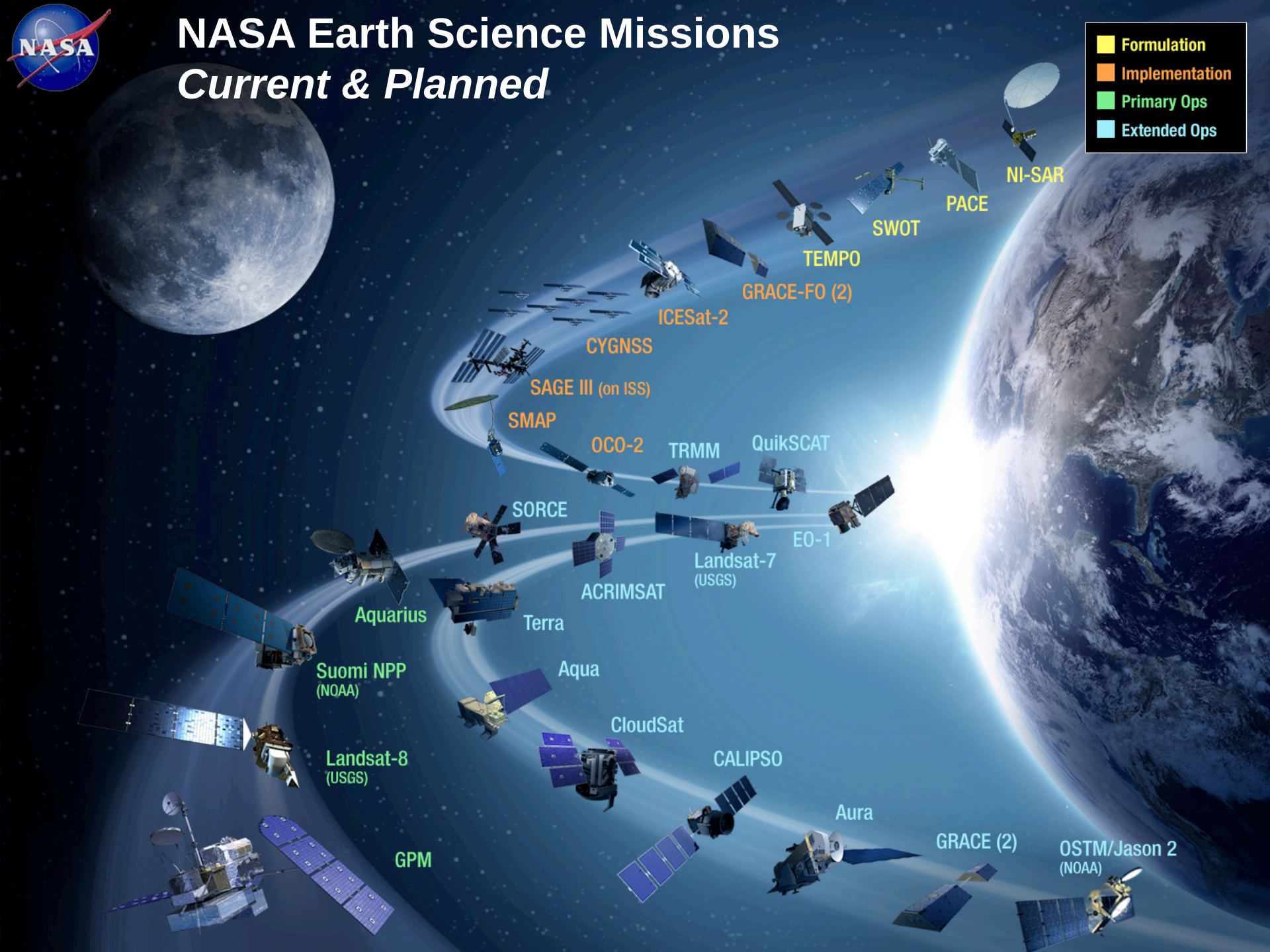
Research and Analysis Program

How do we conduct our work:

- **Open competition**
- **Build partnerships**
- **Verify and validate results**
- **Publish**
- **Share with our partners**

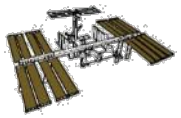


NASA Earth Science Missions
Current & Planned



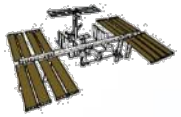
Near Term Mission Plans

GPM
Feb 2014
w/ JAXA; Precip



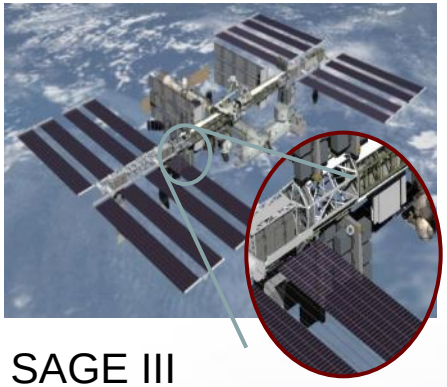
RapidScat
Ocean winds
June 2014

OCO-2
July 2014
Global CO_2



CATS
Aerosols
Sept.2014

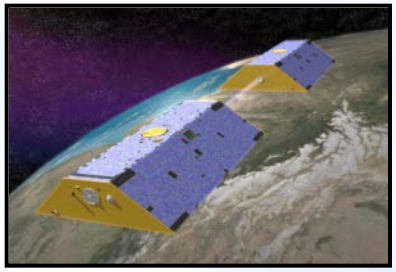
SMAP (w/ CSA)
Nov. 2014
Soil Moist.,Frz/Thaw



SAGE III
Mar 2015; on ISS
Ozone & Trace Gases

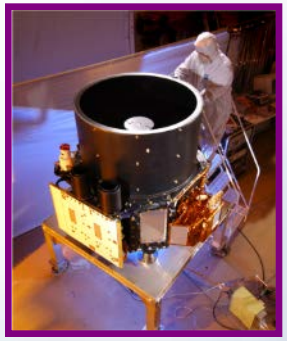
SWOT
Oct 2020
w/CNES; Sea surface &
Fresh water height, slope

TEMPO
2019
Hosted Payload:
Tropospheric
pollution



GRACE FO
Aug 2017
w/Germany; Global Mass
& Water Variation

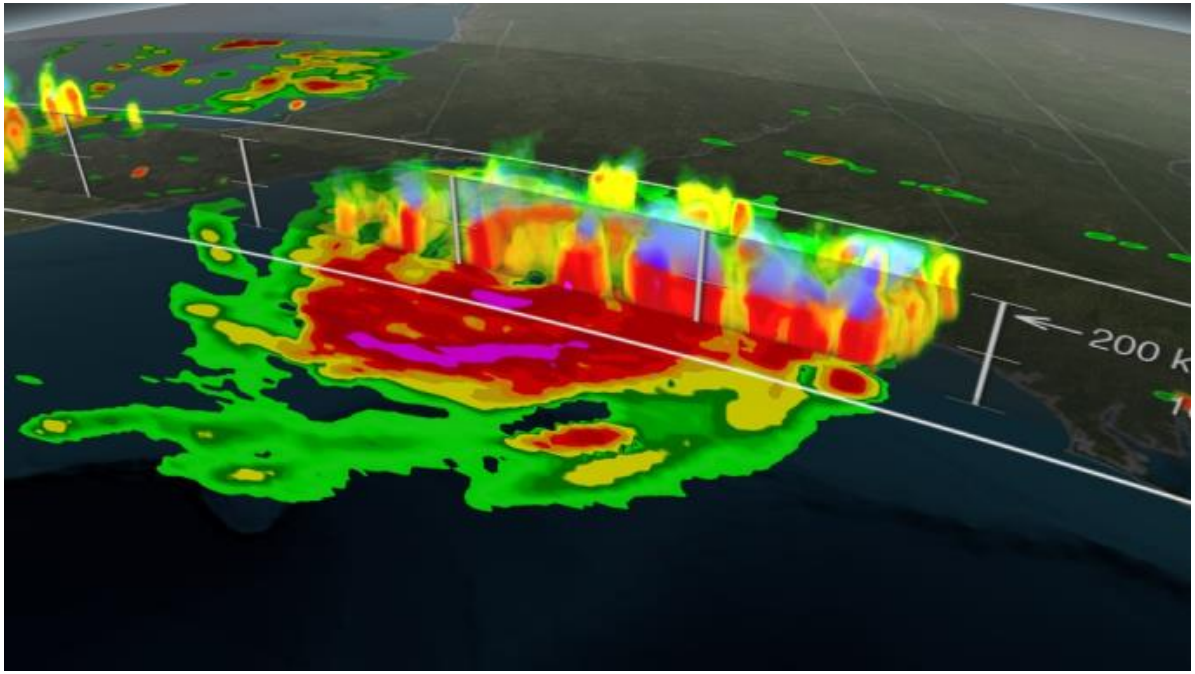
CYGNSS
2016
Cyclone
Generation



ICESat-2
2016
Ice Dynamics

GPM Data Releases

- **July 14th**: GMI Level 2 Precipitation Rate data released early.
- **Early-Mid September**: Release of all Level 2 GMI and DPR data and gridded Level 3 data.
- **December**: Level 3 Integrated Multi-Satellite Retrievals for GPM (IMERG) will be released.

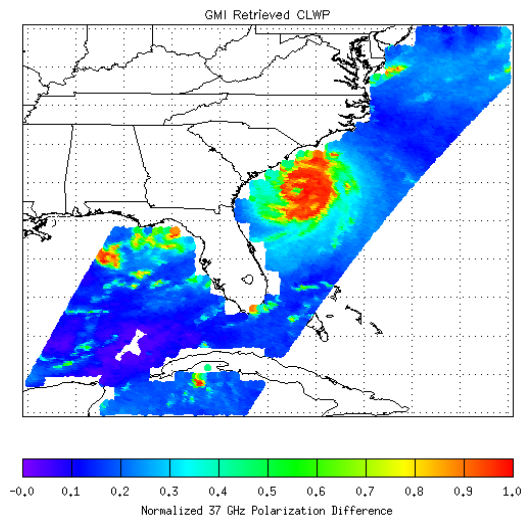


GMI/DPR image of Hurricane Arthur as it moved northwards on July 3rd, 2014. Both heavy rain (green and red colors) near the Earth's surface and ice aloft (blue) can be observed as the storm intensifies.

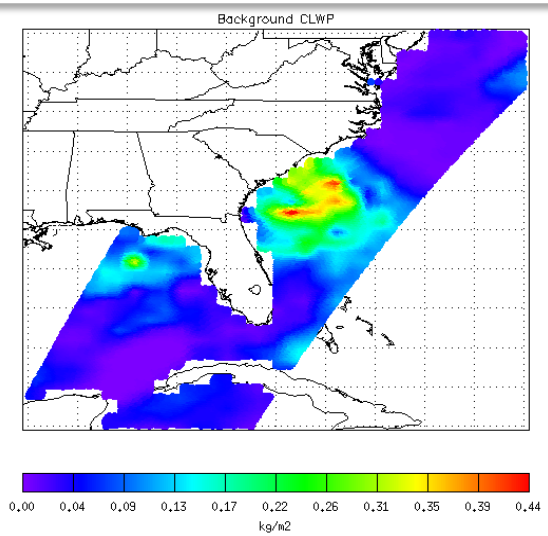
GLOBAL PRECIPITATION MEASUREMENT

Assimilation of GPM Data for Cloud and Precipitation Analysis

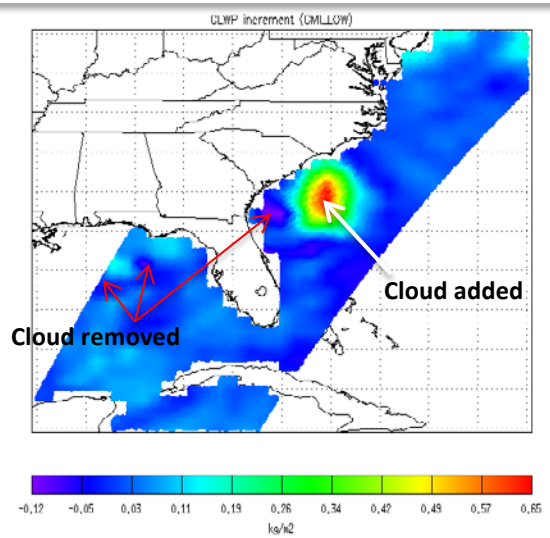
GPM Microwave Imager Observations
Hurricane Arthur (3 July 2014)



GEOS-5 6hr Cloud Water Forecast
before assimilating GPM Microwave Imager data



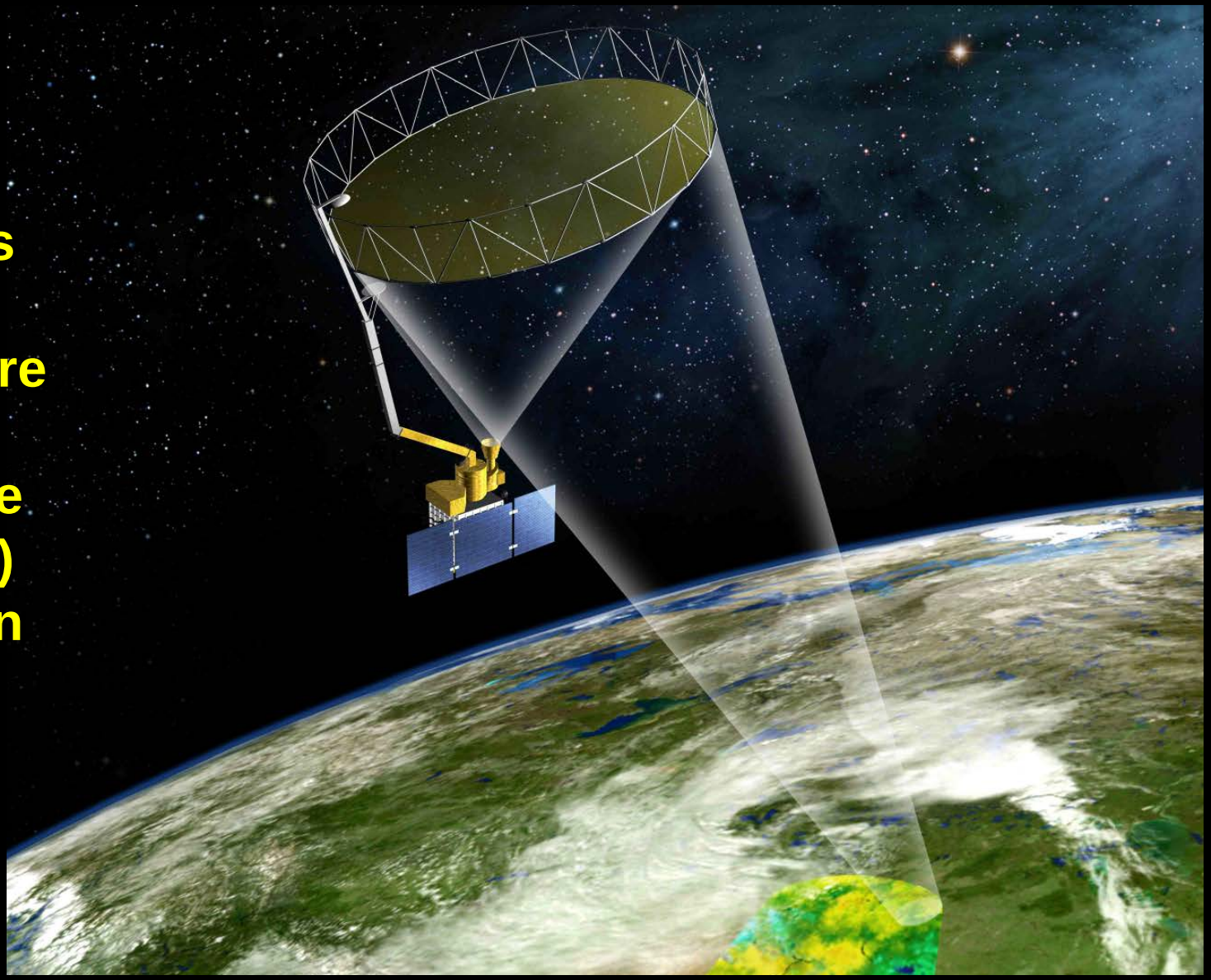
GEOS-5 Cloud Analysis Increment
after assimilating GPM Microwave Imager data



GMAO is currently developing the all-sky radiance data assimilation system to utilize GPM Microwave Imager (GMI) radiance data in GEOS-5 to improve global cloud and precipitation analyses. This will contribute to improve near-real time weather forecasts including severe storms like hurricanes.

Figure Credit: Min-Jeong Kim, Jianjun Jin, Will McCarty, Ricardo Todling, and Ron Gelaro

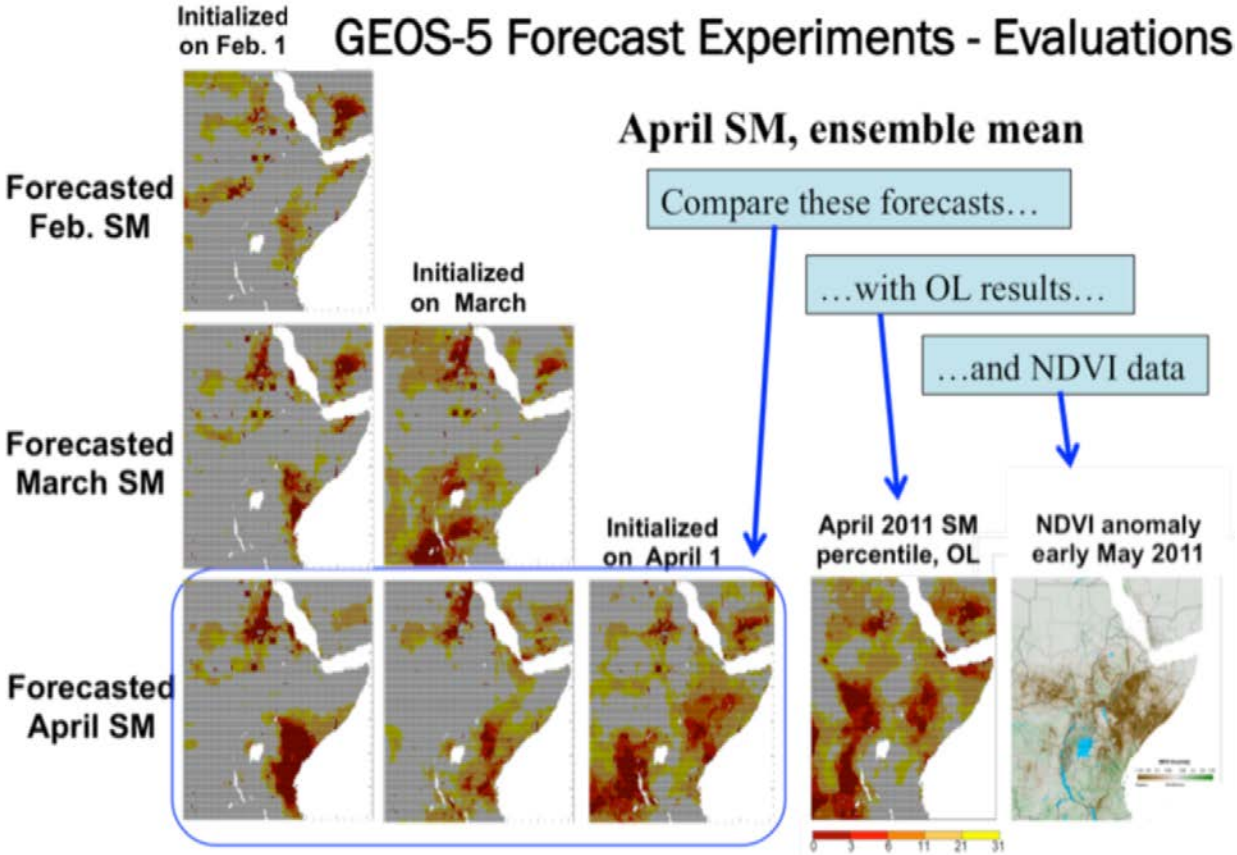
NASA's Soil Moisture Active Passive (SMAP) Mission



SMAP Products

Product	Description	Resolution	Latency	
L1A_TB	Radiometer Data in Time-Order	-	12 hrs	Instrument Data
L1A_S0	Radar Data in Time-Order	-	12 hrs	
L1B_TB	Radiometer T_B in Time-Order	36x47 km	12 hrs	
L1B_S0_LoRes	Low Resolution Radar σ_o in Time-Order	5x30 km	12 hrs	
L1C_S0_HiRes	High Resolution Radar σ_o in Half-Orbits	1-3 km	12 hrs	
L1C_TB	Radiometer T_B in Half-Orbits	36 km	12 hrs	
L2_SM_A	Soil Moisture (Radar)	3 km	24 hrs	Science Data (Half-Orbit)
L2_SM_P	Soil Moisture (Radiometer)	36 km	24 hrs	
L2_SM_A/P	Soil Moisture (Radar+Radiometer)	9 km	24 hrs	
L3_F/T_A	Freeze/Thaw State	3 km	50 hrs	Science Data (Daily Composite)
L3_SM_A	Soil Moisture (Radar)	3 km	50 hrs	
L3_SM_P	Soil Moisture (Radiometer)	36 km	50 hrs	
L3_SM_A/P	Soil Moisture (Radar+Radiometer)	9 km	50 hrs	
L4_SM	Soil Moisture (Surface and Root Zone)	9 km	7 days	Science Value-Added
L4_C	Carbon Net Ecosystem Exchange (NEE)	9 km	14 days	

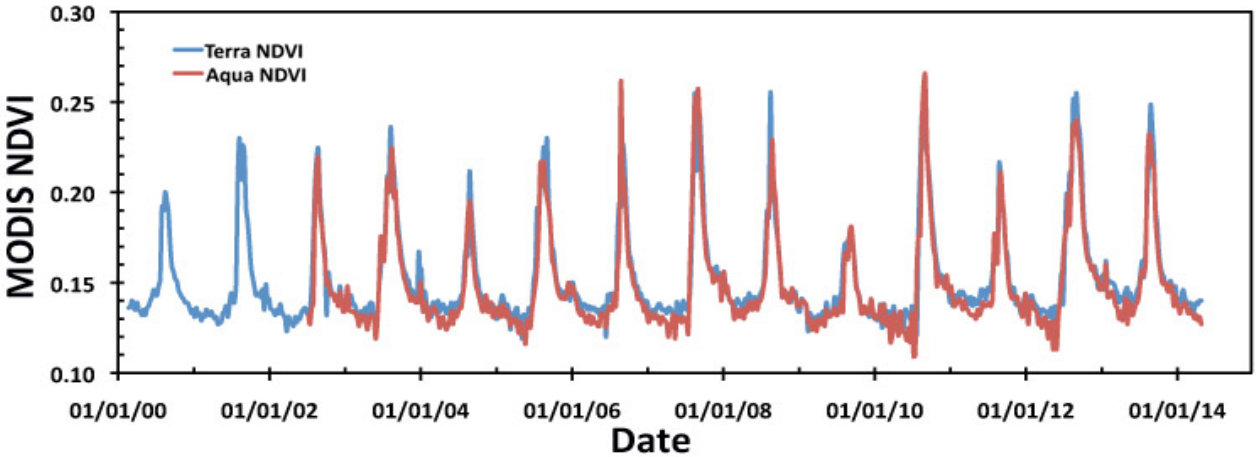
Ensemble Modeling of Soil Moisture (SM) for FEWS NET

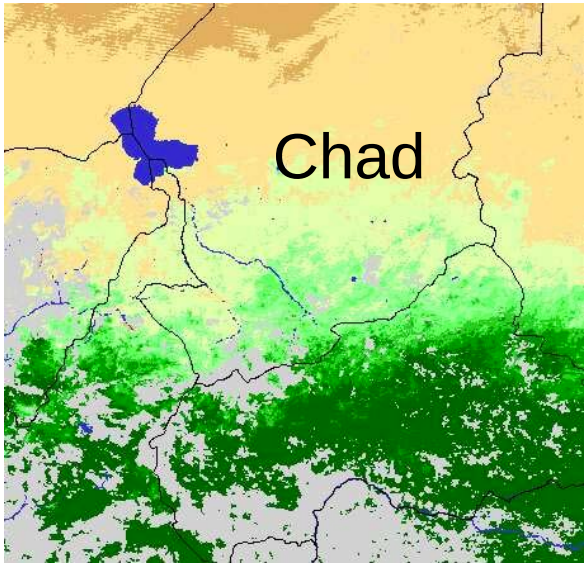


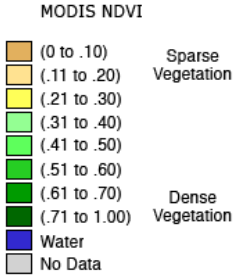
Soil moisture percentiles predicted using LIS/CLSM with input forecasts from GEOS-5 for the Horn of Africa in February, March and April 2011, with GEOS-5 forecasts initialized on February 1, March 1 and April 1.

This project has an **ARL of 8**, where the functionality of the system has been proven and the product used under certain conditions.

Food Production Monitoring

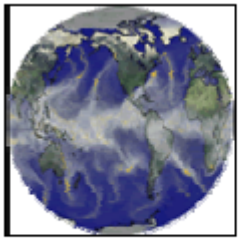




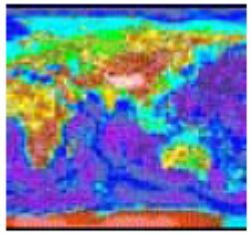


- MODIS NDVI data from the west side of Lake Chad in the West African Sahel
- This data is used operationally by the US Department of Agriculture's Foreign Agriculture Service's Crop Explorer
- The satellite data system is an **ARL 9**, since the product is used operationally in decision making, and has helped to improve our understanding of global food production

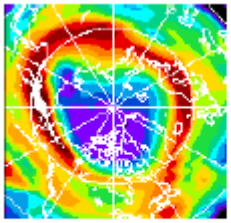
Global Models



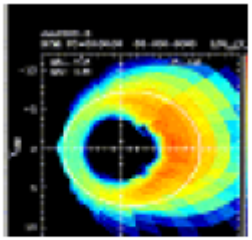
GEOS-5 AGCM
Atmosphere Model



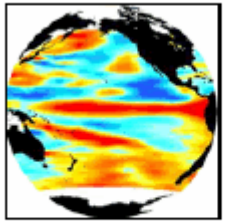
GSFC GOCART
Aerosol Transport



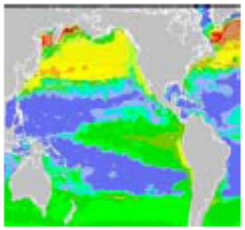
Goddard Atmospheric
Chemistry and
Transport Model



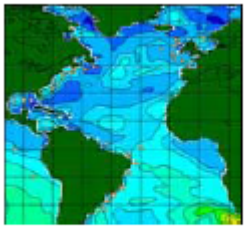
RMC Model
Inner Magnetosphere



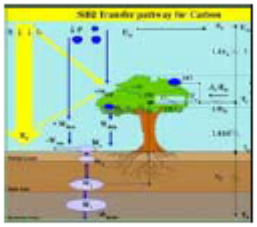
GMAO Ocean Analysis



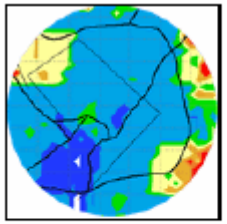
Global Ocean Biology



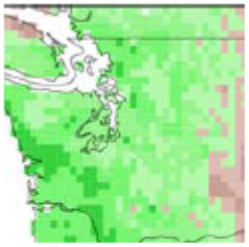
WAVEWATCH III
Ocean Wind
Wave Model



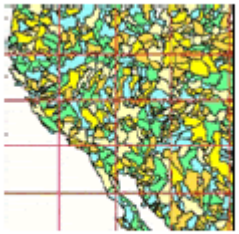
SiB2
Biosphere Model



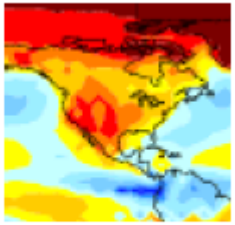
GSFC Global LIS



Mosaic LSM

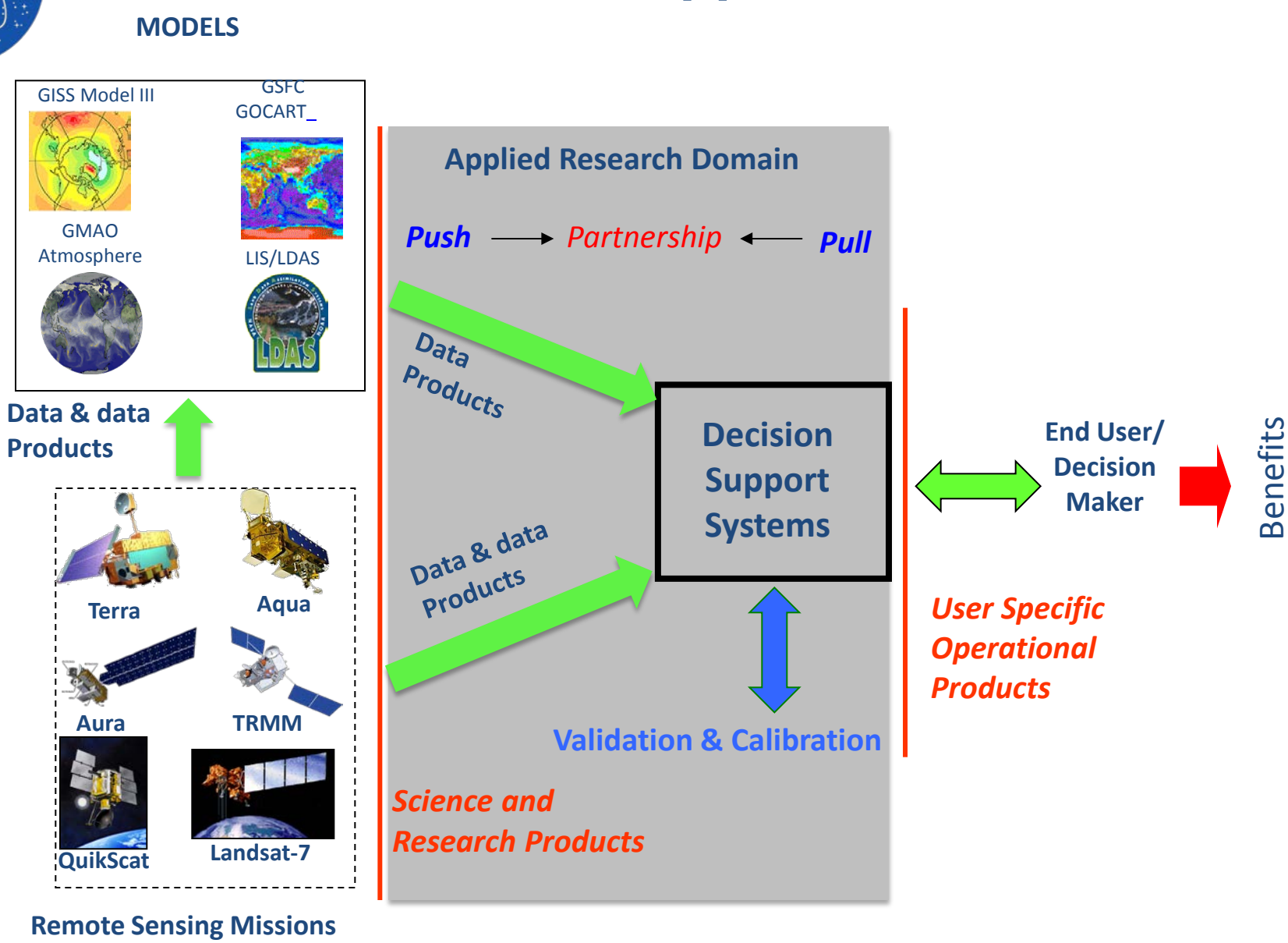


GSFC Catchment LSM

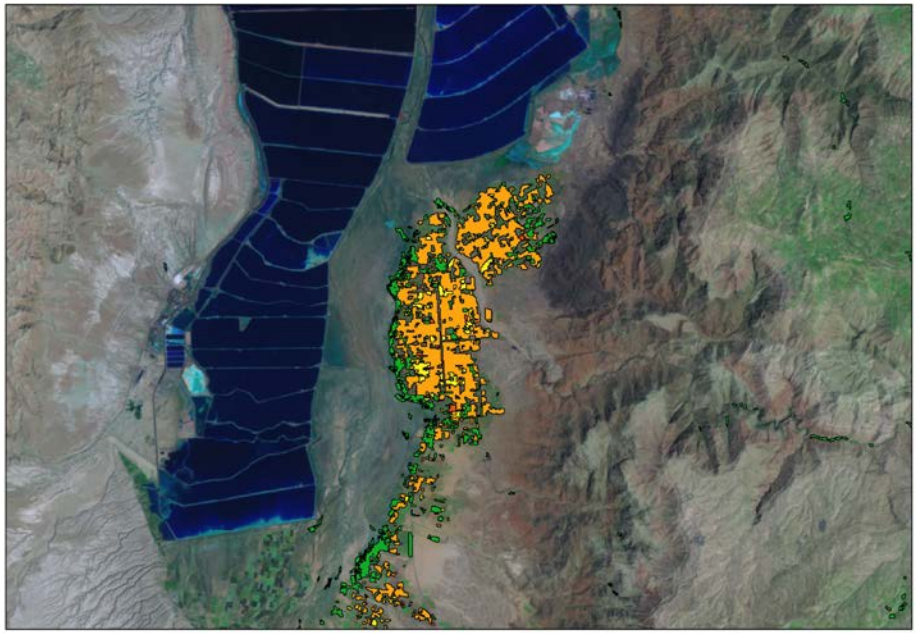


GISS Model E
Climate Model

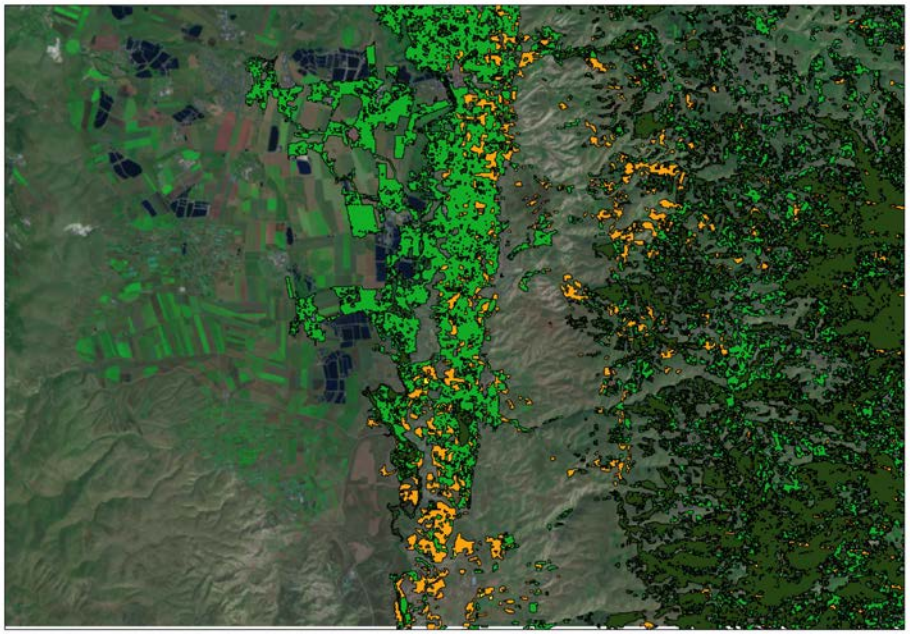
Research to Application



Crop and Irrigation Mapping-Jordan



South Dead Sea irrigated agriculture



North Jordan Valley irrigated agriculture

<u>Two stage approach</u>

- MODIS-based mapping (at 500 meter) for regional land surface and hydrological modeling
- Landsat-based mapping for use in local scale water and crop growth assessment

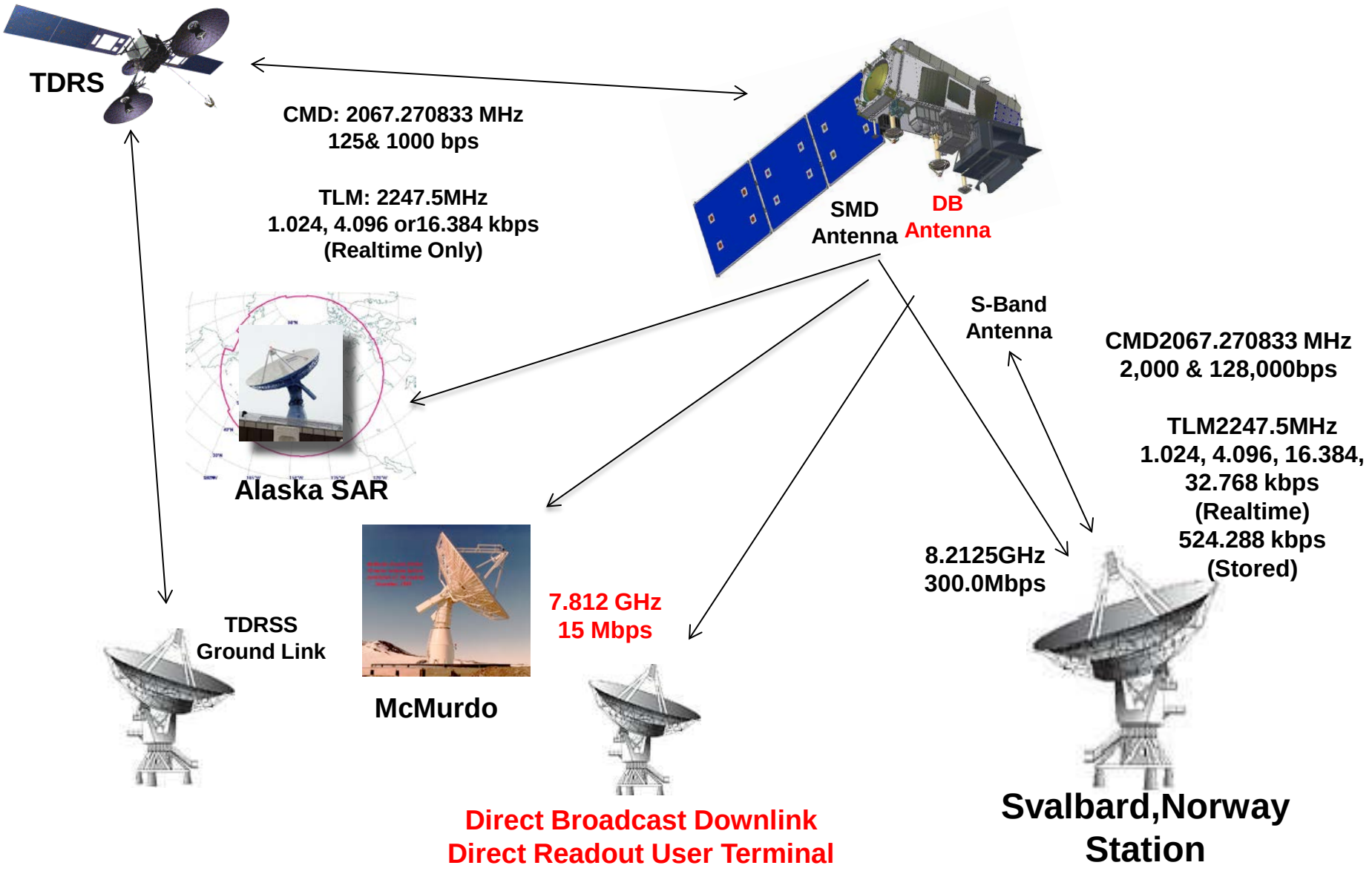
Natural Vegetation

Permanent Vegetation-olives

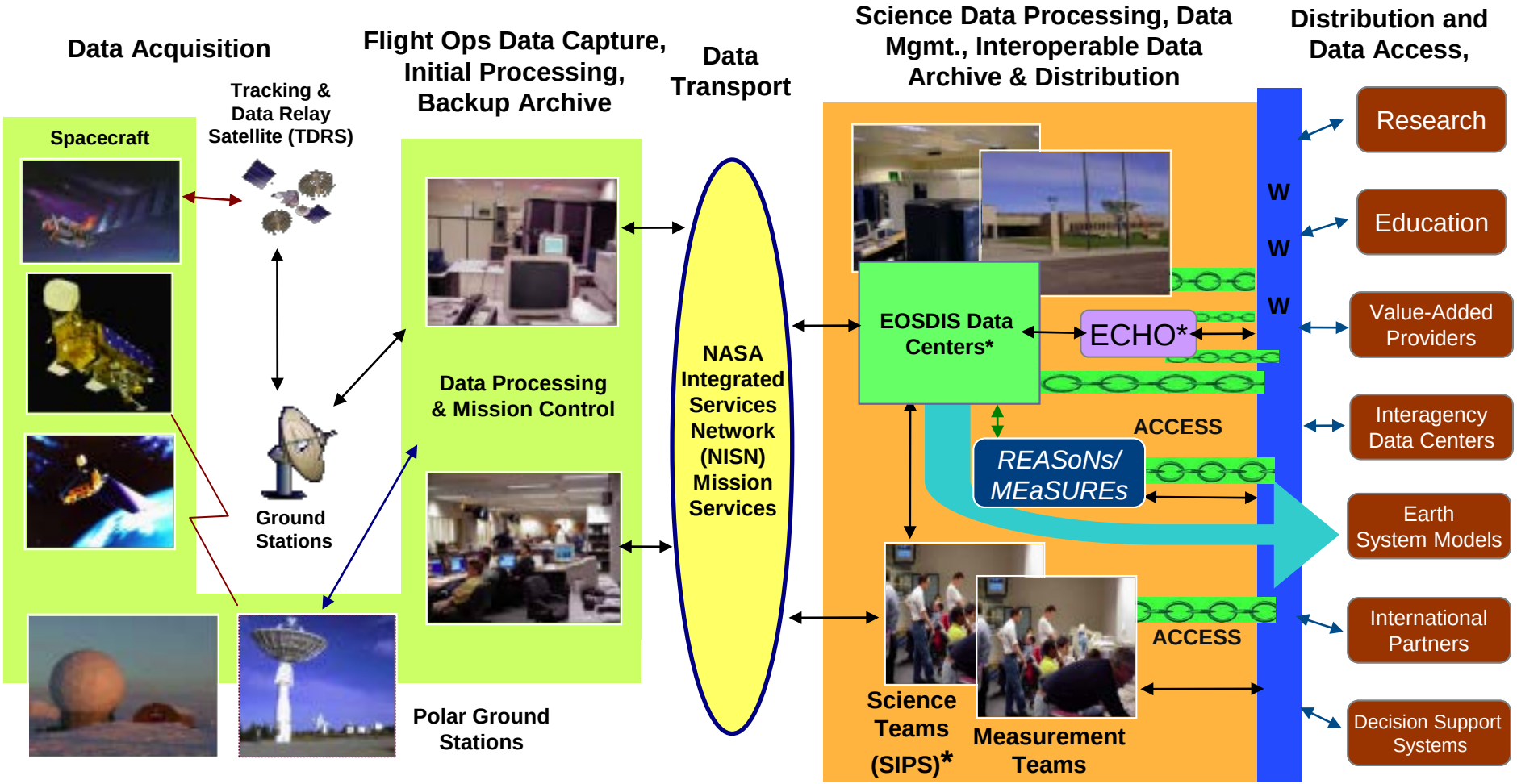
Spring irrigated

Summer irrigated

Spacecraft Communication Links

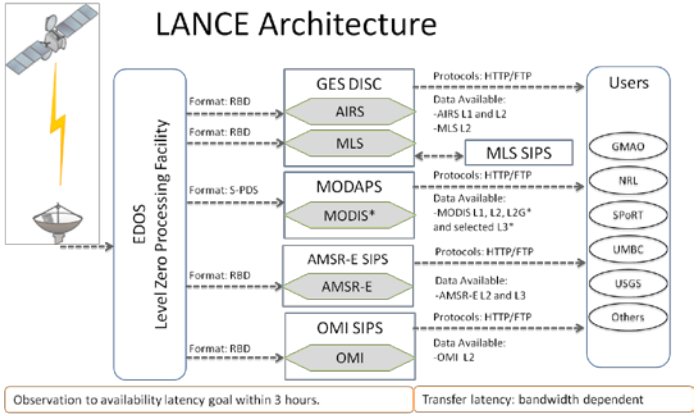


Overall Systems Architecture



LANCE and GIOVANNI

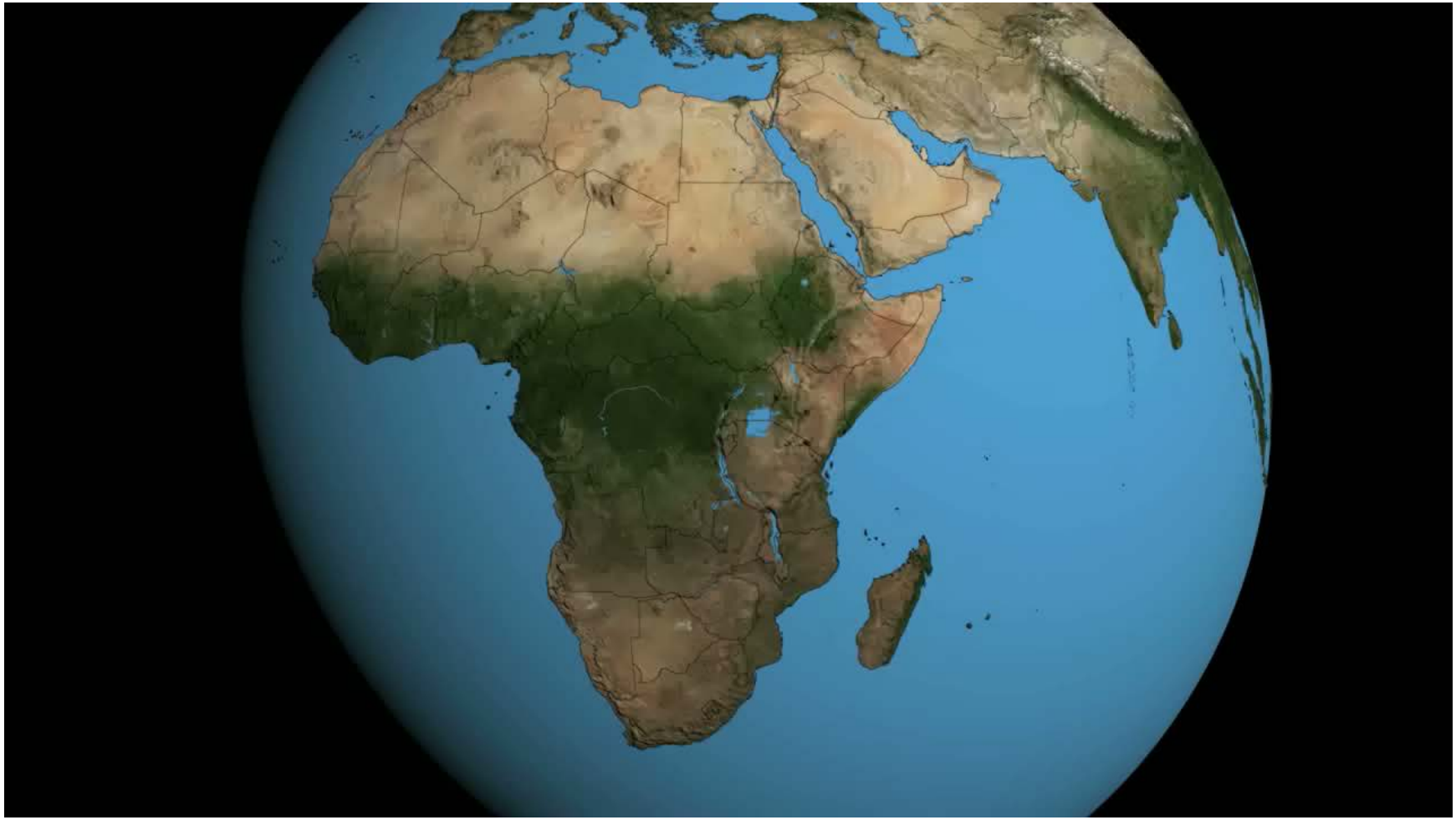
- Building on existing EOSDIS elements Land, Atmosphere Near Real Time Capability for EOS (LANCE) provides data from MODIS, OMI, AIRS, MLS, and AMSR-E instruments in near real-time (< 3 hours from observation, http://lance-modis.eosdis.nasa.gov)
- **Giovanni is a Web-based application developed by the Goddard Earth Sciences Data and Information Services Center (GES DISC)** that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data. Giovanni is an acronym for the **G**eospatial **I**nteractive **O**nline **V**isualization **AN**d a**N**alysis **I**nfrastructure (http://disc.sci.gsfc.nasa.gov/giovanni/overview/what-is-giovanni)
  - Numerical weather & climate prediction/forecasting
  - Monitoring of Natural Hazards
  - Drought Early Warning
  - Disaster Relief
  - Agricultural Monitoring
  - Air Quality
  - Homeland Security



NASA has Open source data policy

- Applies to NASA data, data products, algorithms and models

Aerosols

Aerosol optical depth fields from GMAO's global 7 km aerosol simulation based on NRT MODIS Quick Fire Emissions Dataset (QFED)

Da Silva/GSFC