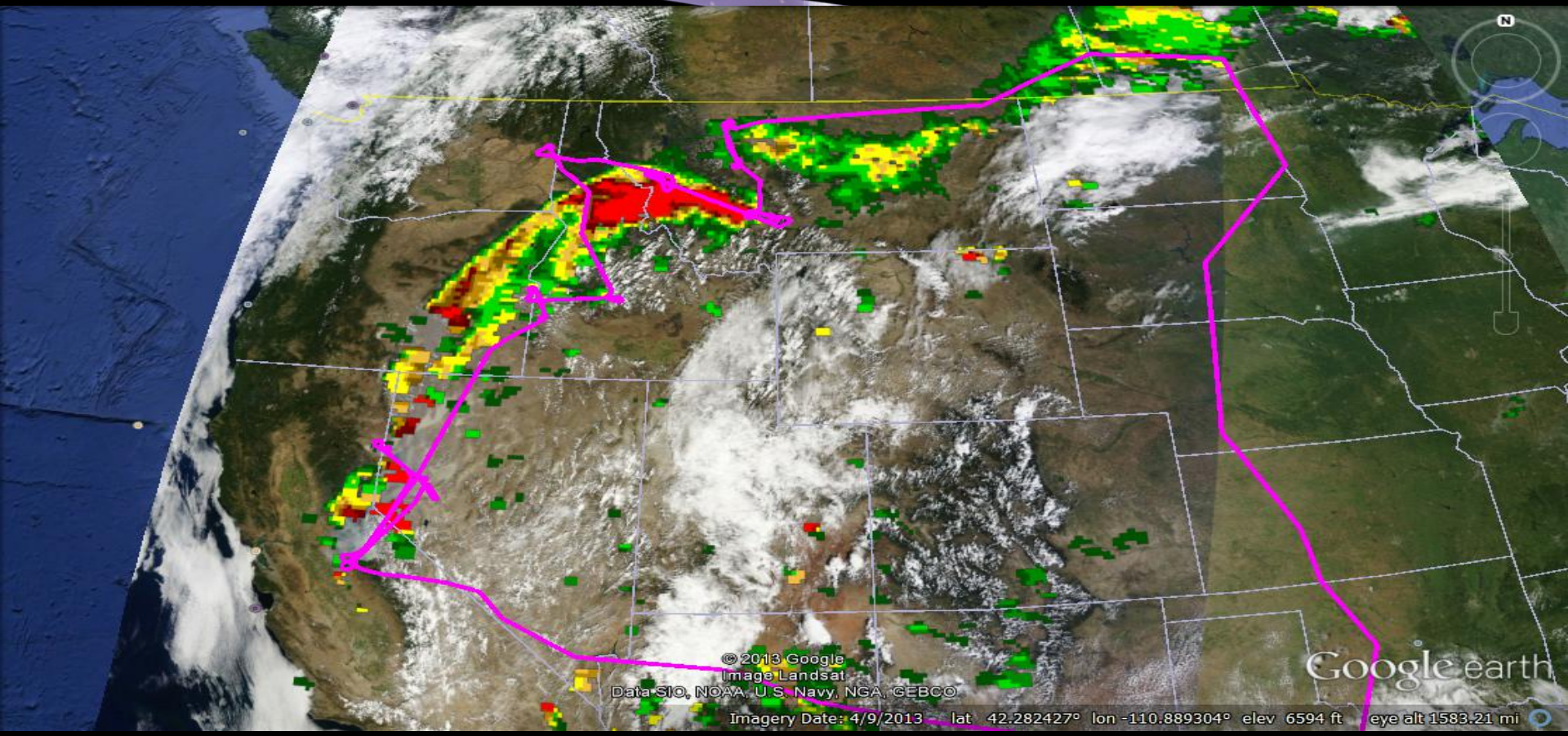
National Aeronautics and Space Administration



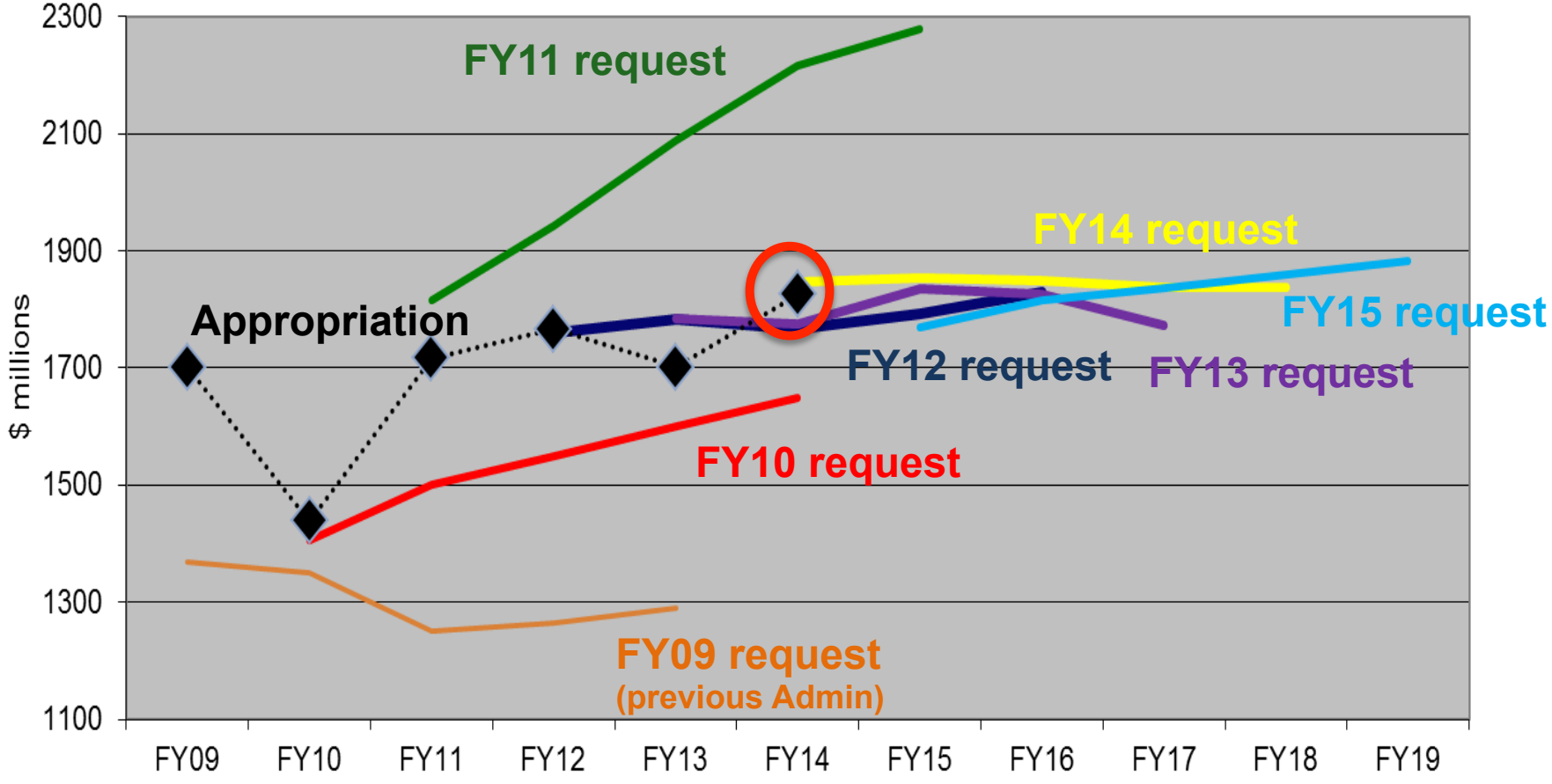
NASA Earth Science

AMS Washington Forum Federal Panel

Michael H. Freilich

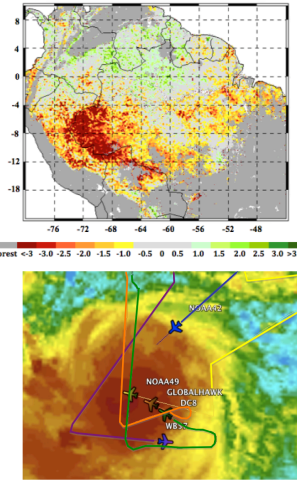
April 2, 2014

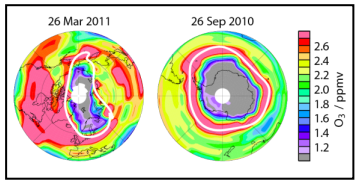
Earth Science Budget: FY15 Request/Appropriation

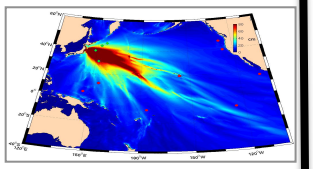


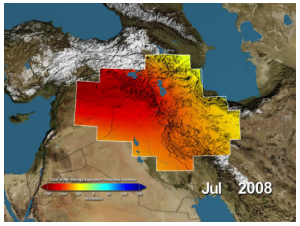
NASA's Earth Science Division

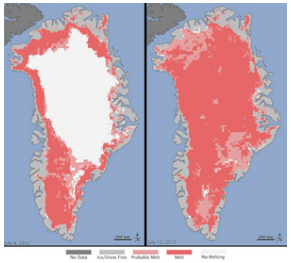
Research



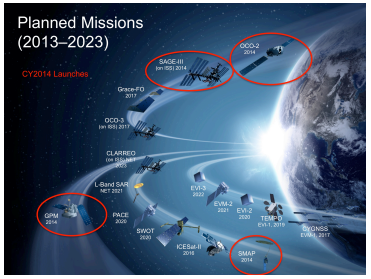


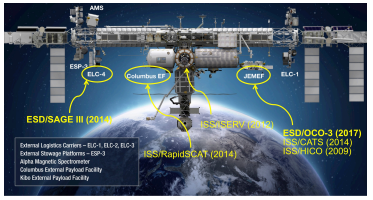




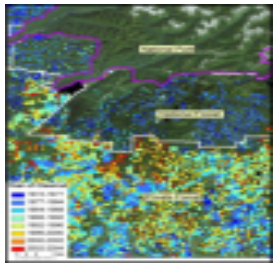


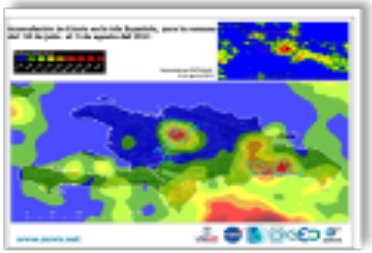
Flight

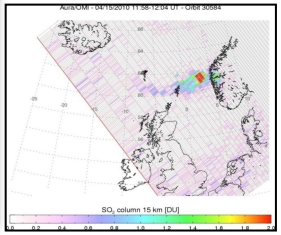


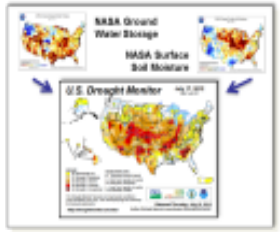


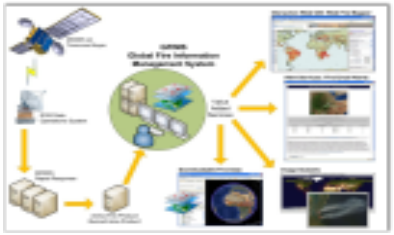
Applied Sciences

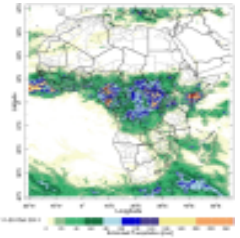




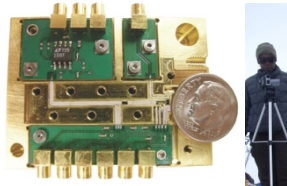


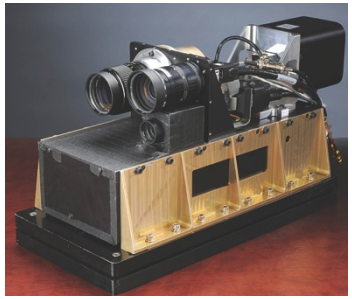


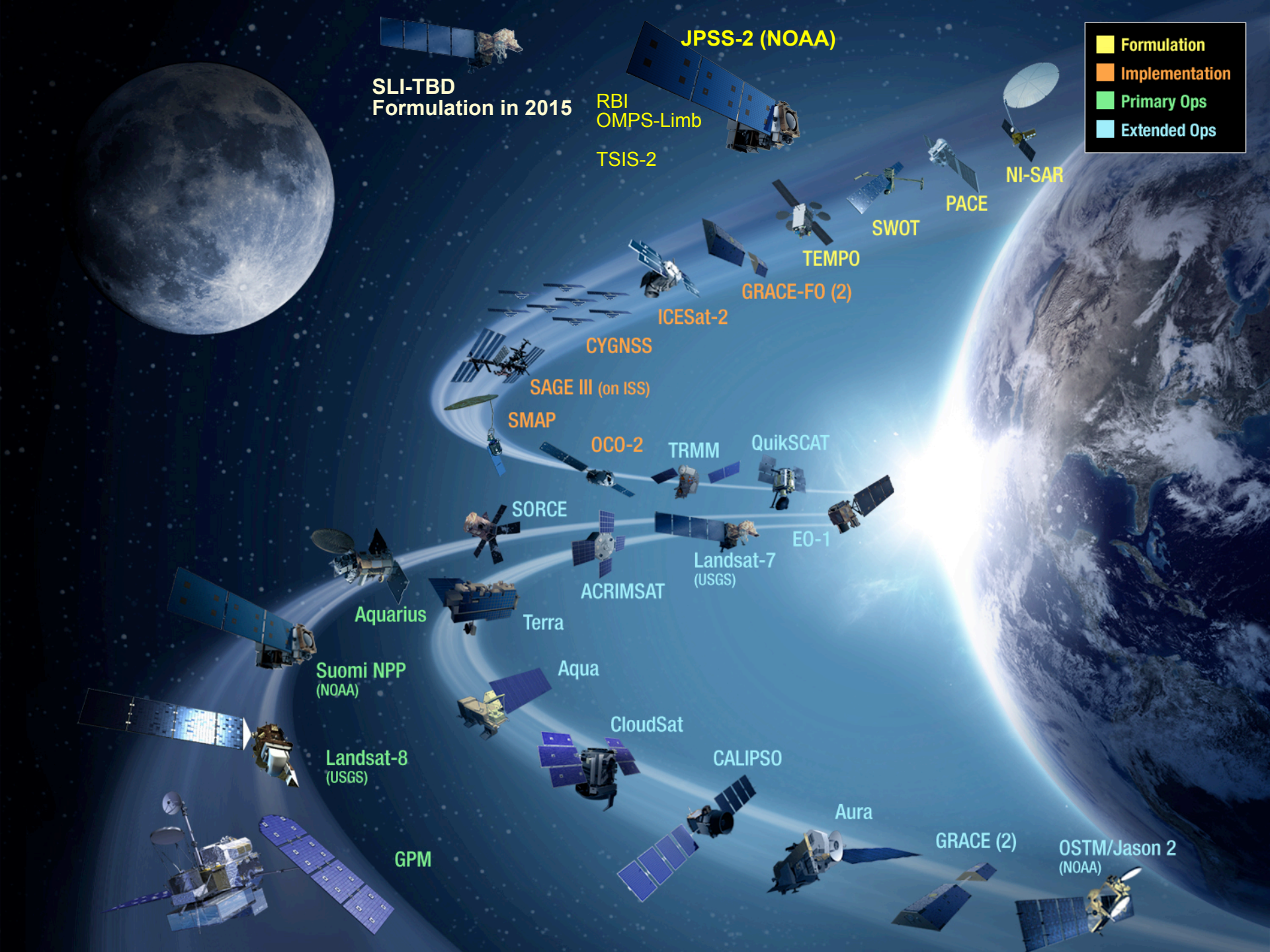




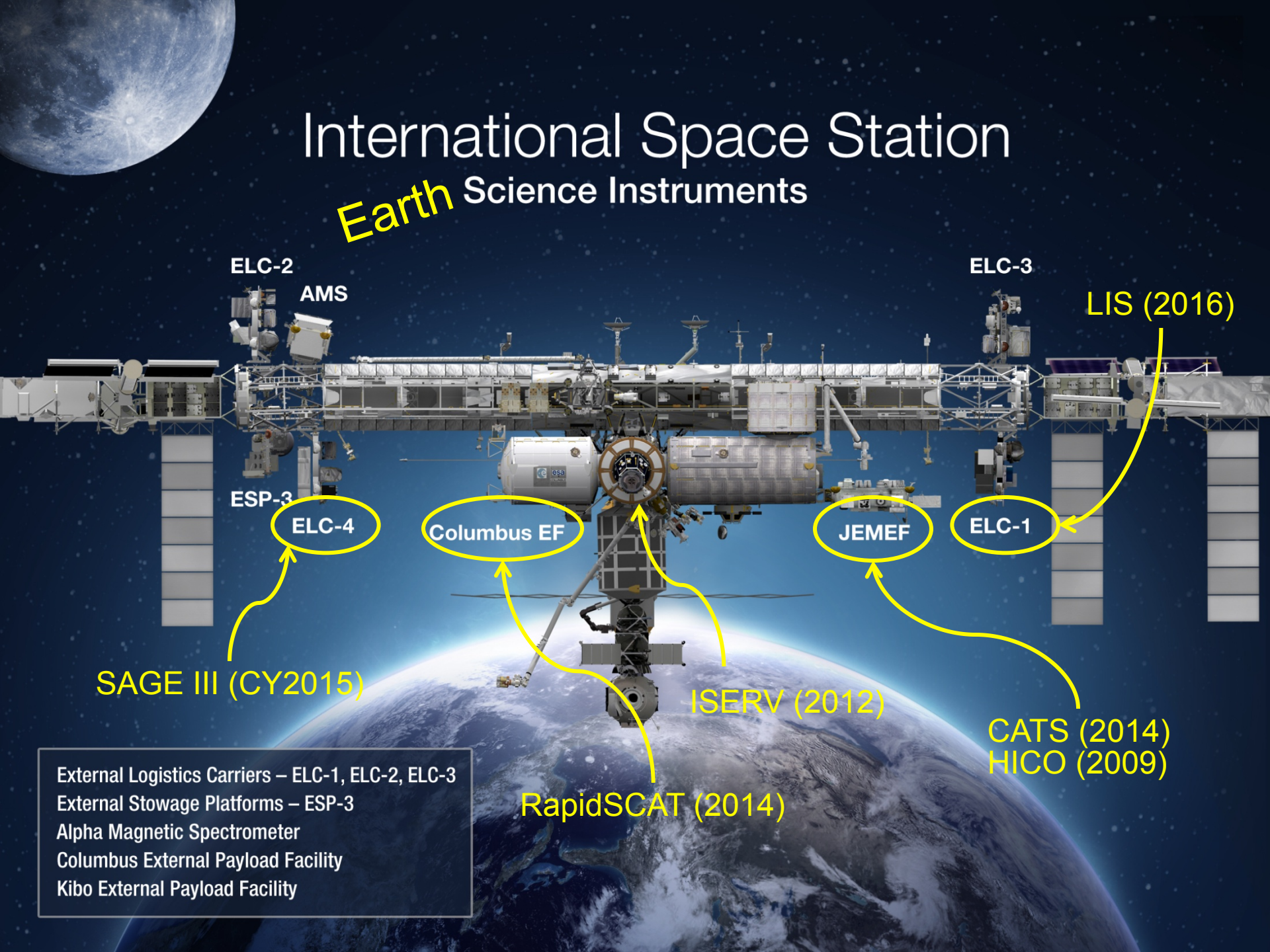
Technology






Formulation
Implementation
Primary Ops
Extended Ops
SLI-TBD
Formulation in 2015
JPSS-2 (NOAA)
RBI
OMPS-Limb
TSIS-2
NI-SAR
PACE
SWOT
TEMPO
GRACE-FO (2)
ICESat-2
CYGNSS
SAGE III (on ISS)
SMAP
OCO-2
TRMM
QuikSCAT
SORCE
EO-1
Landsat-7
(USGS)
ACRIMSAT
Aquarius
Terra
Suomi NPP
(NOAA)
Aqua
CloudSat
Landsat-8
(USGS)
CALIPSO
GPM
Aura
GRACE (2)
OSTM/Jason 2
(NOAA)


3 ESD-developed EO missions launch in CY 2014
2 ISS-developed EO instruments in 2014, 1 in 2016
9 more ESD EO launches before 2022
OCO-2
7/2014
SAGE-III
(on ISS)
CY2015
Grace-FO
2017
RapidSCAT, CATS
(on ISS) 2014
LIS
(on ISS) 2016
(NOTIONAL)
CLARREO
NET 2023
NI-SAR
~2020/2021
GPM
2/2014
PACE
~2020
SWOT
2020
EVI-3
2022
EVM-2
2021
EVI-2
2020
TEMPO
EVI-1, ~2019
CYGNSS
EVM-1, 2016
ICESat-2
Likely CY2018
(TBR)
SMAP
11/2014


International Space Station
Earth Science Instruments
ELC-2
AMS
ELC-3
LIS (2016)
ESP-3
ELC-4
Columbus EF
JEMEF
ELC-1
SAGE III (CY2015)
ISERV (2012)
CATS (2014)
HICO (2009)
RapidSCAT (2014)
External Logistics Carriers – ELC-1, ELC-2, ELC-3
External Stowage Platforms – ESP-3
Alpha Magnetic Spectrometer
Columbus External Payload Facility
Kibo External Payload Facility

VENTURE-CLASS UPDATE/STATUS

- EV-S ("EV-1" - Suborbital, Airborne; solicited every 4 years)
  - All 5 investigations are well into their sustained field campaigns
  - All EV-1 investigations flew during 2013
  - **Second EV-S solicitation released 6/2013, proposals received 1/10/2014**
  - ***FY14 President's budget includes EV-Suborbital/3 on-schedule***

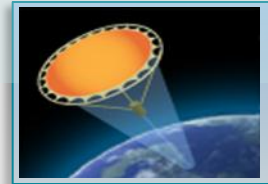
- EV-M ("EV-2" - Small-sat; solicited every 4 years)
  - CYGNSS successful KDP-B in 7/2013, planned LRD 10/2016-4/2017
  - ***FY15 President's budget includes EV-M/2 solicitation on-schedule in 6/2015***

- EV-I (Instrument; solicited every 18 months)
  - **TEMPO selected for GEO hosted payload opportunity (early FY18 launch)**
  - ESD making excellent progress on formal host selection
  - **Second "EV-I/2" solicitation released 7/2013, proposals received 11/25/2013**
  - ***FY15 President's budget includes EV-Instrument/3 and subsequent solicitations on-schedule***

Earth Science Technology Office (ESTO) Opportunities

The Earth Science Technology Office is a ***targeted, science-driven, competed, and actively managed technology program.*** The investment elements include:

Observation



Instrument Incubator Program (IIP)
robust new instruments and measurement techniques
17 new projects added in FY14 (total funding approximately $71M over 3 years)

Information

Advanced Component Technologies (ACT)
development of critical components and subsystems for instruments and platforms
15 new projects added in FY11 (total funding approximately $16M over 3 years)

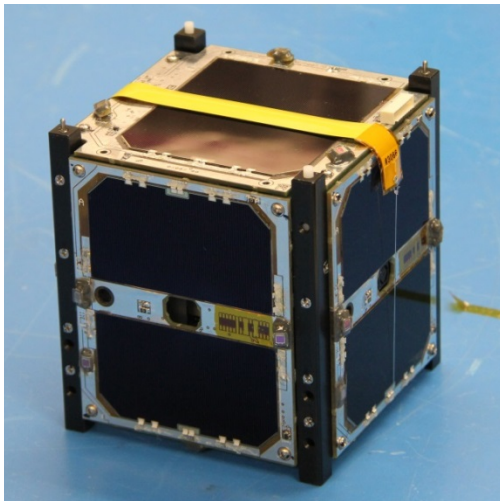
Advanced Information Systems Technology (AIST)
innovative on-orbit and ground capabilities for communication, processing, and management of remotely sensed data and the efficient generation of data products
18 new projects added in FY12 (total funding approximately $23M over 3-4 years)

Validation

In-Space Validation of Earth Science Technologies (InVEST)
on-orbit technology validation and risk reduction for small instruments and instrument systems that could not otherwise be fully tested on the ground or airborne systems
First 4 projects added in FY13 (total funding ~$13M over 3 years)

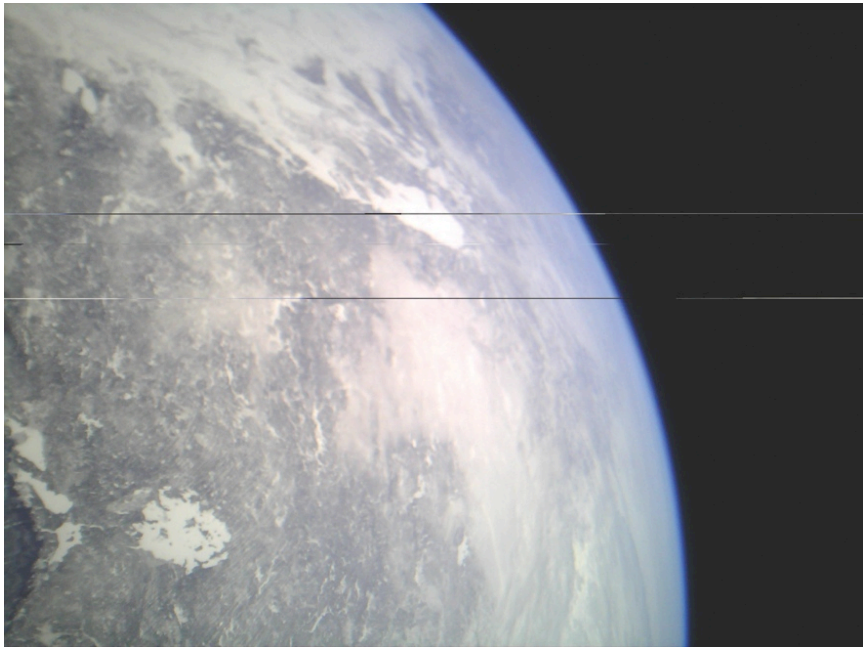
The current portfolio of active investments supports all of the 2007 NRC Decadal Survey mission concepts. 65% directly support Tier 1 and 2 missions, ~ 15% support Tier 3 missions, and the remainder are crosscutting.

Technology Highlight:
COVE – Validating an On-Board Data Processing Technology in Space



The Michigan Multipurpose Minisatellite (MCubed-2) CubeSat, a collaboration between JPL and the Univ. of Michigan, launched in December 2013 as a secondary payload aboard NROL-39. The CubeSat is validating algorithm and processor technologies for the Multiangle Spectropolarimeric Imager (MSPI), a candidate for the ACE mission concept.

The payload – JPL-developed CubeSAT On-Board Processing Validation Experiment (COVE) – is a polarimetry data processing algorithm implemented on a new radiation-hard-by-design FPGA (the first production Xilinx Virtex-5QV to fly in space). This technology could reduce the future MSPI data downlink requirements by two orders of magnitude.



One week after launch, an auto-run sequence using stored imagery was executed and validated against known results. Since then, COVE has been further validated against the ground-based testbed using imagery taken by the MCubed-2 camera, completing all Level-1 requirements.

In coming months, COVE will continue to acquire and process sufficient imagery to characterize the performance of the hardware and software over extended temperature fluctuations, radiation, and longer acquisition periods.

Top: The MCubed-2 CubeSat. (Credit: D. Smith, UM)
Bottom: Image of snow-covered Midwest and Canada used in the Level-1 validation run of COVE. (Credit: S. Kang, UM)

PI: Paula Pingree, JPL; Co-I: James Cutler, UM

NASA/ESD Applied Sciences Program

Applications Themes

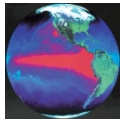

Health


Water


Disasters


Ecosystems

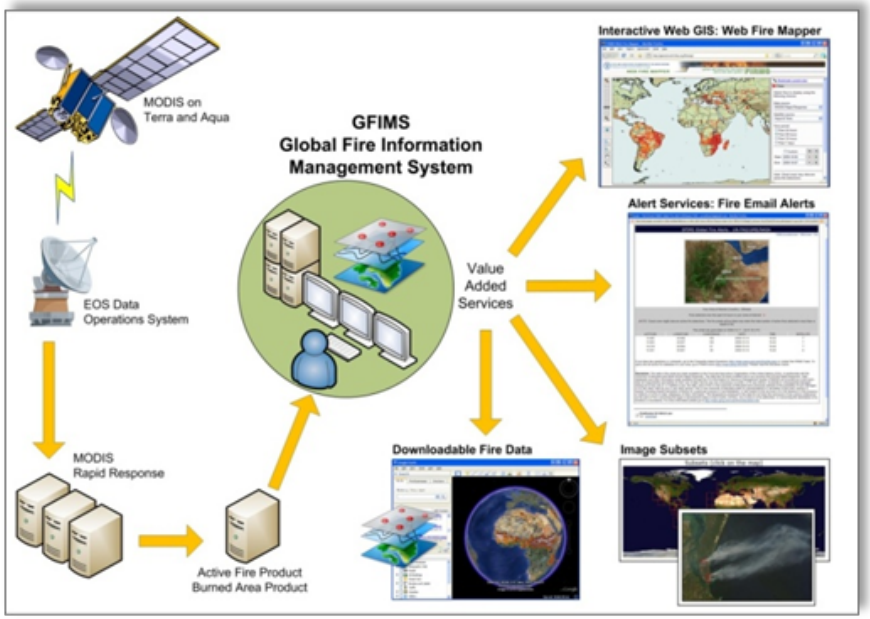

Agriculture


Climate

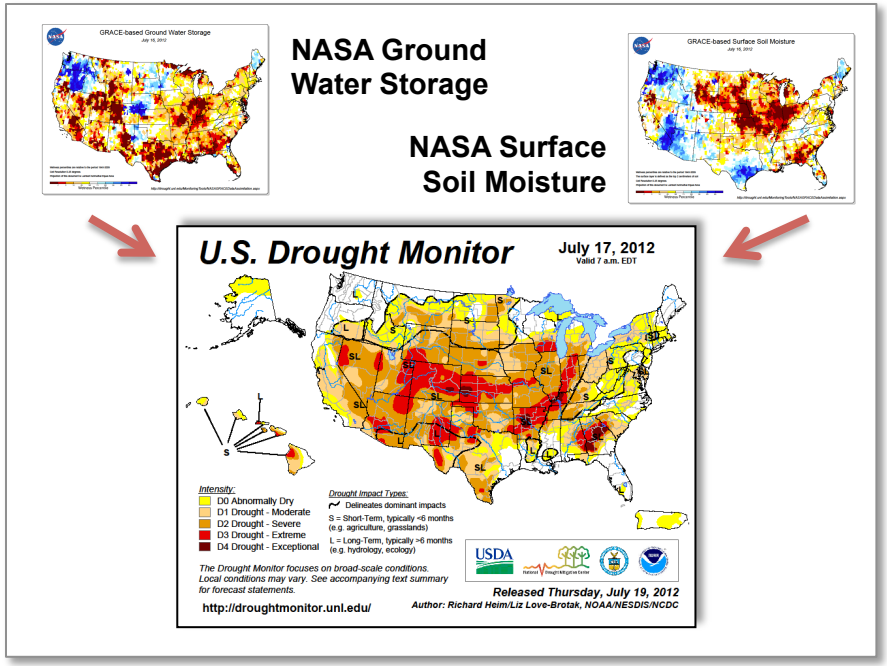
Energy


Oceans


Weather



United Nation's system now using data from NASA's Terra and Aqua satellites to identify fires and send alerts to remote areas via SMS and text messages.



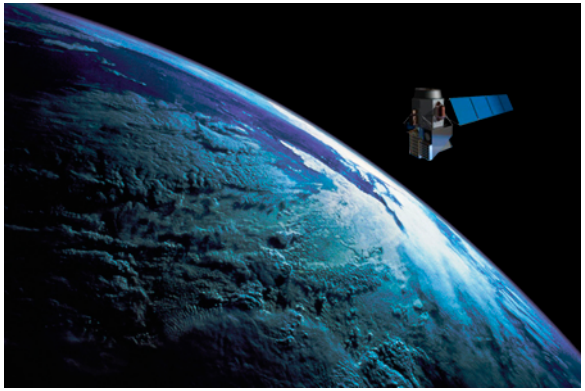
USDA/NOAA managed weekly U.S. Drought Monitor now using NASA GRACE data as part of analysis in creation of national and state-level maps..

Venture-Class

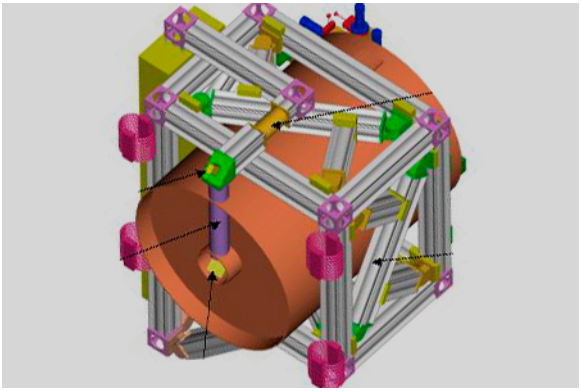
- Science-driven, PI-led, competitively selected, cost- and schedule-constrained, regularly solicited – Venture-Class is a ***high-priority Decadal Survey Recommendation***
- Complement the systematic missions, provide flexibility to accommodate scientific advances and new implementation approaches
- ***All ongoing and planned investigations, solicitations, and selections are on track and fully funded***

3 "Strands"

Suborbital



Small-sat/Missions



Instruments

Land Imaging in FY 2014 President's Budget and FY14 Omnibus Appropriation Bill

In FY14 ***NASA will initiate*** *the definition of a sustained, space-based, global land imaging capability for the nation, ensuring continuity following LDCM. Near-term activities* ***led by NASA****, in cooperation with USGS, will focus on studies to define the scope, measurement approaches, cost, and risk of a viable long-term land imaging system that will achieve national objectives. Evaluations and design activities* ***will include consideration of stand-alone new instruments and satellites, as well as potential international partnerships****. It is expected that* ***NASA will support*** *the overall system design, flight system implementation, and launch of future missions, while* ***USGS will continue to fund ground system development****, post-launch operations, and data processing, archiving, and distribution.*

- President's FY2014 Budget release for NASA

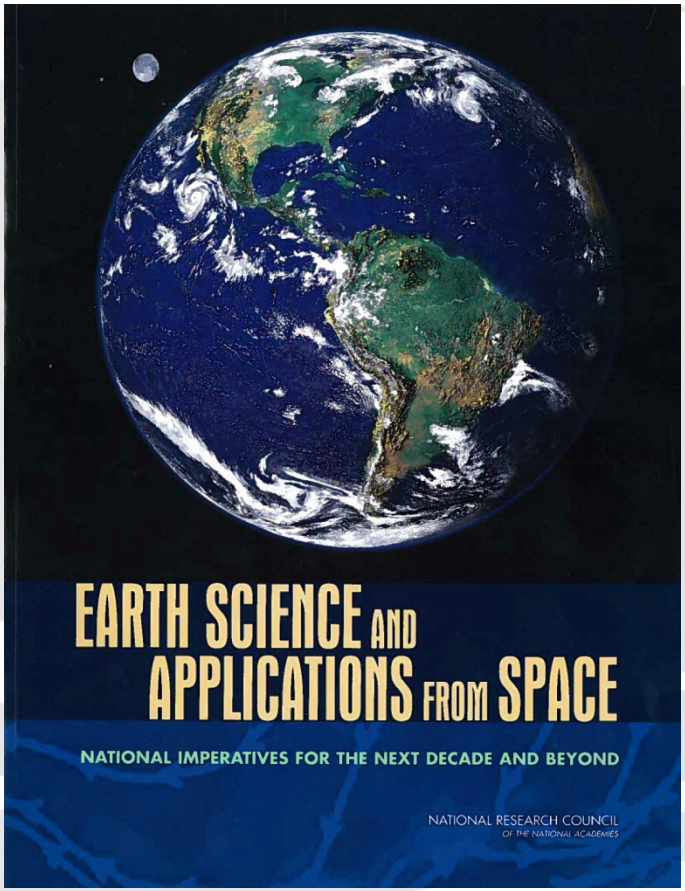
Land Imaging.—The Committee commends NASA and its team for the recent successful launch of Landsat 8, and provides $30,000,000 for Land Imaging activities…. However, the Committee is concerned about the administration's approach towards the follow-on Landsat 9 mission…. The Committee is highly skeptical of either a hosted payload or international partner concept for Landsat 9. The Committee discourages NASA from spending an inordinate amount of time or funds on these alternate approaches…. At the same time, expectations that a Landsat 9 mission will cost a billion dollars due to enhanced new instrumentation or other efforts at program resiliency are equally unrealistic. For this reason, the Committee expects a plan not later than 120 days after enactment of this act detailing how Landsat 9 will ensure data continuity … with an overall mission cap of approximately $650,000,000, a level substantially below that required for Landsat 8.

-- Senate Language incorporated into FY14 Appropriation

Sustained Land Imaging

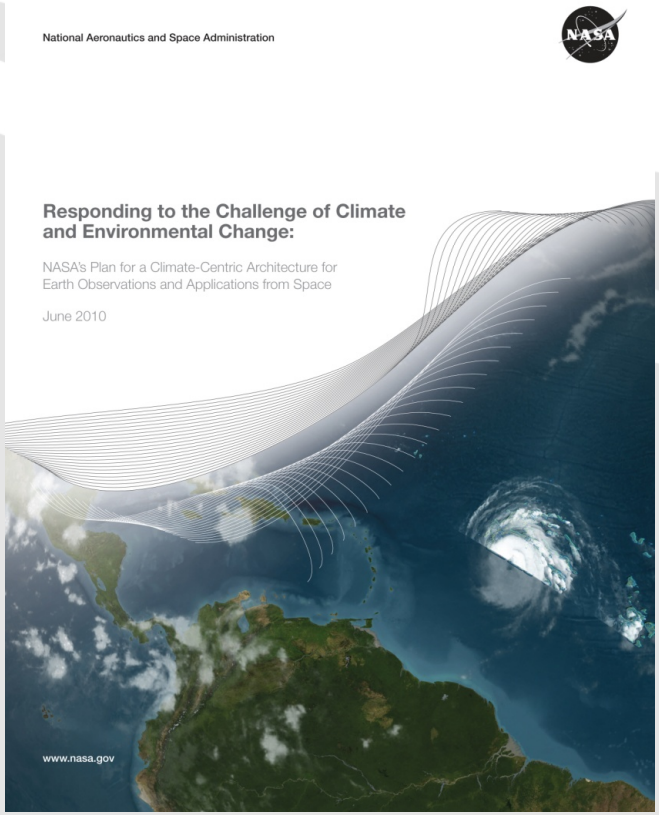
- FY14 President's budget proposal calls for NASA to lead the architecture design and space component implementation of a **sustained system** for moderate-resolution, global land imaging – with USGS
- NASA role:
  - System architecture study lead
  - Design, implement, launch, on-orbit commissioning of USG spaceborne segment (if any)
- USGS role:
  - Represent user communities in system architecture study
  - Post-commissioning operations, downlink, ground data processing, data distribution, archiving
- System characteristics:
  - 20-year lifetime, 2018-2038
  - Consistent with and continue 41-year Landsat data set
  - Products consistent with Landsat-7 and LDCM/Landsat-8 bands and data products
- Study guidance from OMB
  - ***Cost is a constraint:*** $120M/year ***NASA*** average cost (and near-flat budget) over system lifetime
  - Examine international and private sector partnerships
  - Specifically examine infusion of hyperspectral technology
  - Balance initial capability, gap risk/continuity, technology infusion over system lifetime, cost
  - Study results due August 2014

Guiding Recommendation Documents



Administration priorities and constraints

Decadal survey,
OCO-2,
climate continuity missions,
balanced program
Integrated Program



2007 Decadal Survey

- Research and Applications communities priorities
- No realistic budget constraint (calls for $2B funding [FY06 constant $$ beginning in FY10)

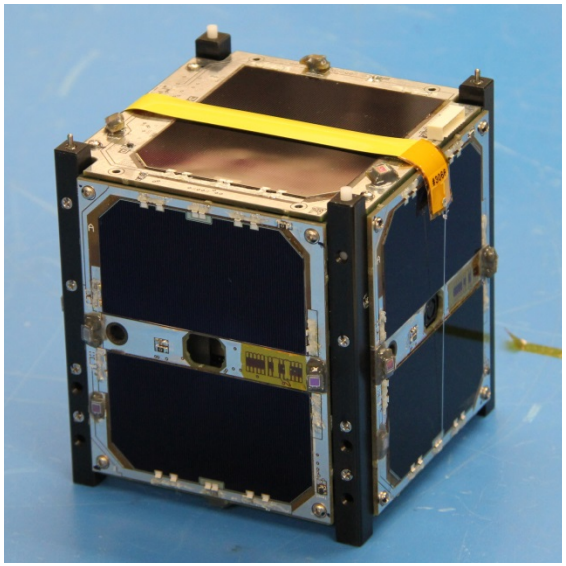
http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf

- Dec Surv + Administration priorities
- Executable for FY11 Pres. Bud.
- OSTP, USGCRP, OMB approval

Two CubeSats Launched December 5, 2013

Two CubeSats launched from Vandenberg Air Force Base this evening on the NROL-39 (Atlas V) that will validate new technologies in the space environment.

MCubed/COVE-2



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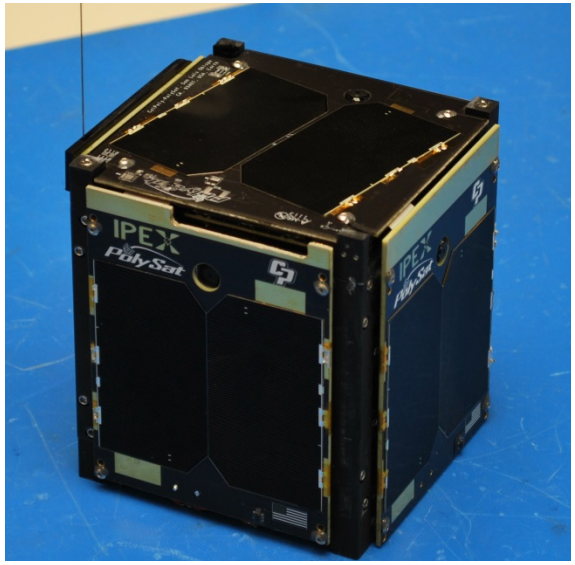
PI: Paula Pingree, JPL; Co-I: James Cutler, UM

The Intelligent Payload Experiment (IPEX), built by Cal Poly San Luis Obispo and JPL, will validate key aspects of the Intelligent Payload Module (IPM) technology, a candidate for the HyspIRI mission concept.

The IPM enables near real-time autonomous product selection and generation providing a 20x reduction in data volume for high data rate thermal infrared imaging and visible to near-infrared spectroscopy instruments.

IPEX



PI: Steve Chien, JPL; Co-I: John Bellardo, Cal Poly SLO

Earth Science Program Overall Strategy

- Maintain a **balanced program** that:
  - **advances Earth System Science**
  - **delivers societal benefit** through applications development and capacity building
  - **provides essential global spaceborne measurements** supporting science and "operations"
  - **develops and demonstrates technologies** for next-generation measurements, and
  - **complements and is coordinated with activities of other agencies and international partners**