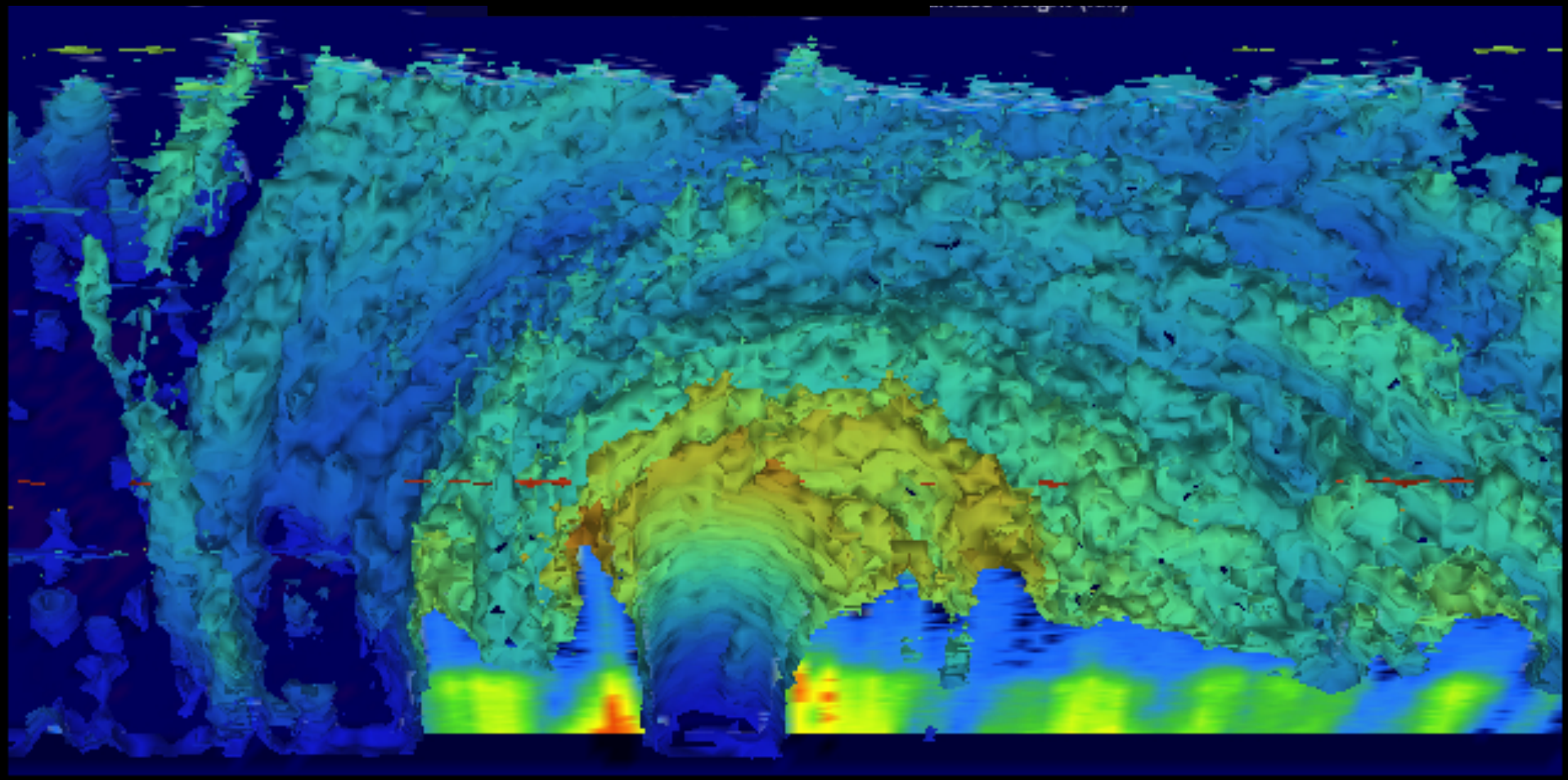
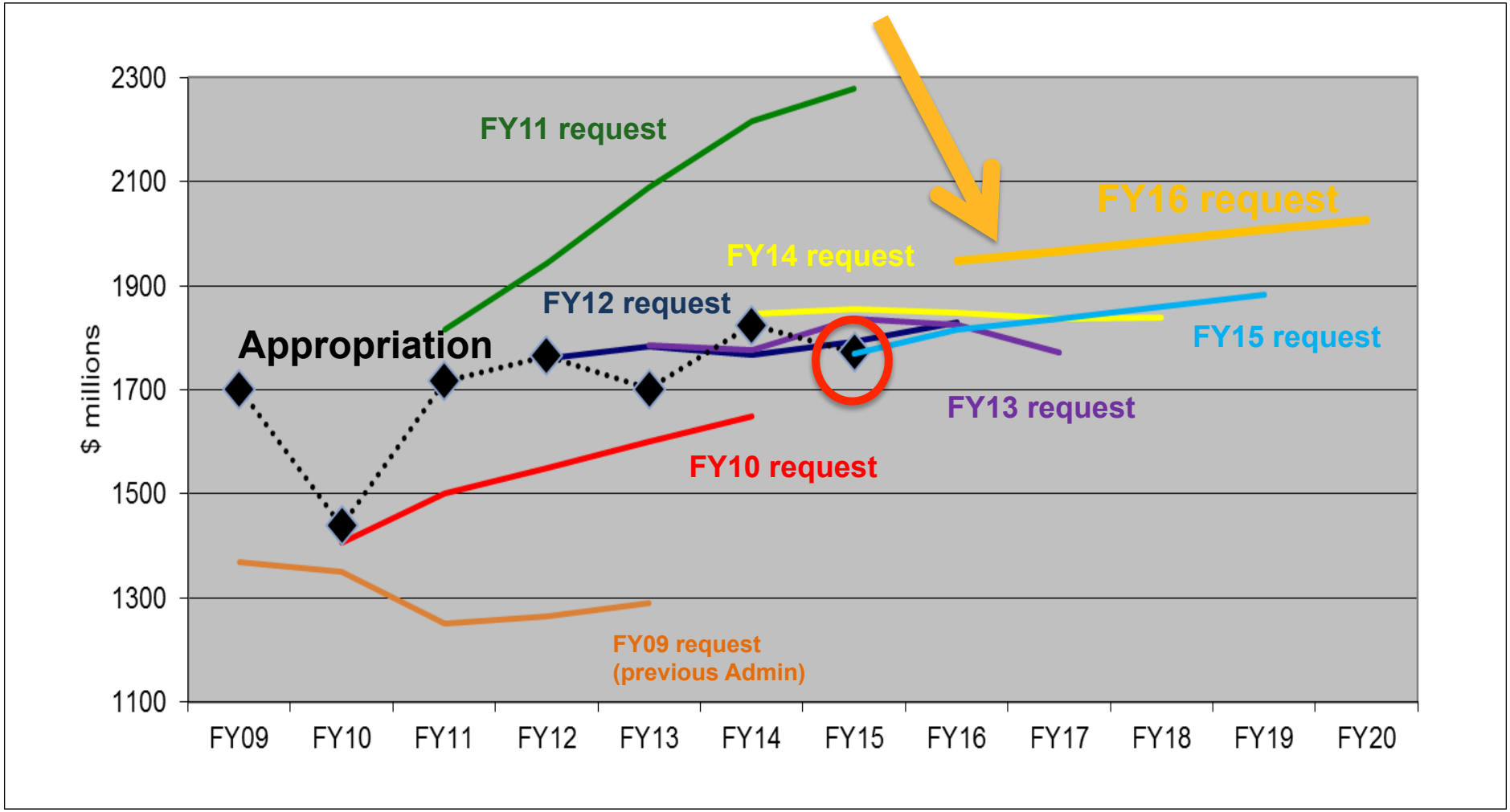
National Aeronautics and Space Administration



ESD: FY16 President's Budget Request Overview and Program Status

19 May 2015

Earth Science Budget:
FY16 Request/FY15 Appropriation



OVERALL SUMMARY (1 of 3)

- ESD budget increases significantly in President's budget request

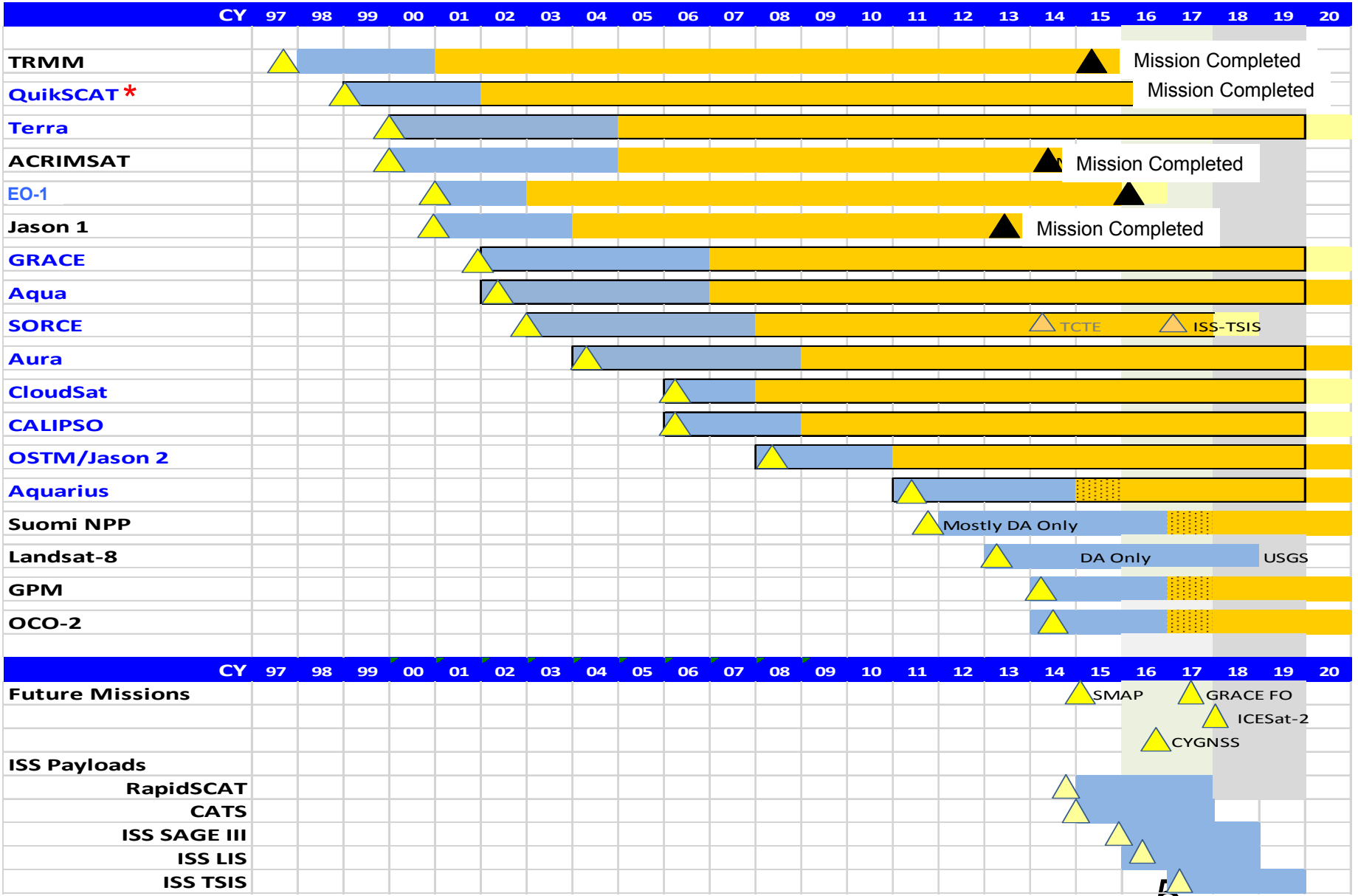
	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**1.730**	**1.894**	**1.913**	**1.932**	**1.952**	**1.971**
FY15		1.762	1.784	1.805	1.829	---

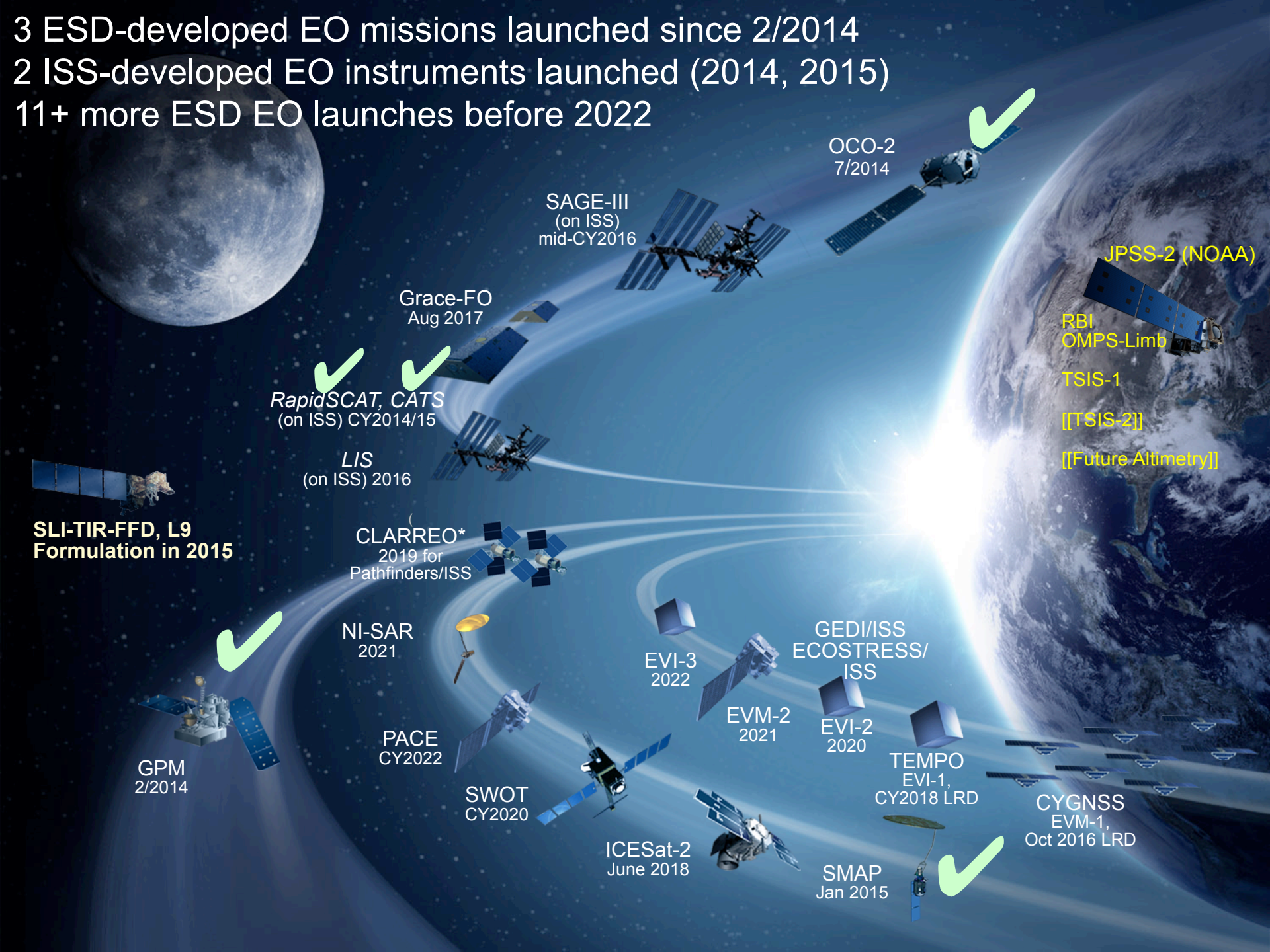
- NASA now has mandate for additional long-term measurements for the nation:
  - Altimetry after Jason-3
  - Solar Irradiance, Ozone Profile, Earth Radiation Budget all starting in FY16
- Sustainable Land Imaging Program (w/USGS; NASA funds flight hardware):
  - TIR-FFD (2019)
  - Upgraded Landsat-9 (2023)
  - Focused technology development to inform designs of Landsat-10+
- Continued development and launch of: SAGE-III/ISS, ECOSTRESS/ISS, GEDI/ISS, CYGNSS, TEMPO, GRACE-FO, ICESat-2, SWOT, NISAR, PACE
- Continue Venture Class on schedule with full funding
- OCO-3 completion and flight to ISS in late 2017
- CLARREO Technology Demonstration instruments on ISS - development and flight in late 2019 (2 instruments, Reflected Solar/HySICS and IR Pathfinder)


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

ED 2015 Senior Review Mission Set

Prime
Extension
Phase F

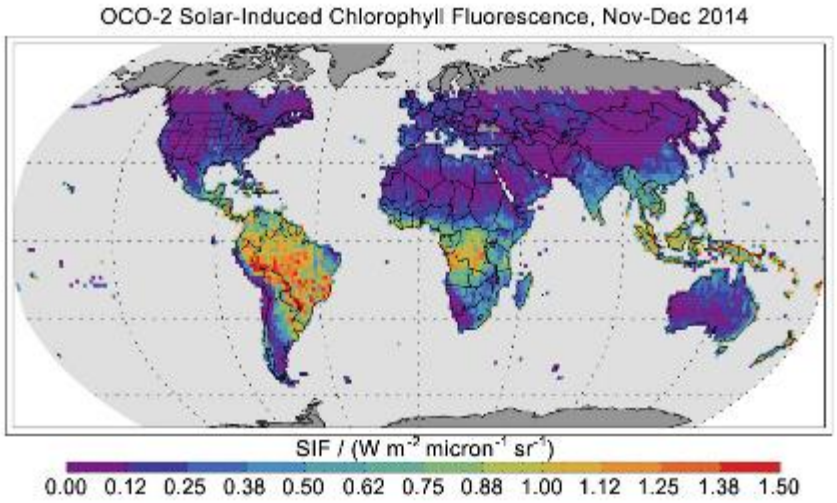



3 ESD-developed EO missions launched since 2/2014
2 ISS-developed EO instruments launched (2014, 2015)
11+ more ESD EO launches before 2022
OCO-2
7/2014
SAGE-III
(on ISS)
mid-CY2016
JPSS-2 (NOAA)
RBI
OMPS-Limb
TSIS-1
[[TSIS-2]]
[[Future Altimetry]]
Grace-FO
Aug 2017
RapidSCAT, CATS
(on ISS) CY2014/15
LIS
(on ISS) 2016
SLI-TIR-FFD, L9
Formulation in 2015
CLARREO*
2019 for
Pathfinders/ISS
NI-SAR
2021
EVI-3
2022
GEDI/ISS
ECOSTRESS/
ISS
EVM-2
2021
EVI-2
2020
TEMPO
EVI-1,
CY2018 LRD
GPM
2/2014
PACE
CY2022
SWOT
CY2020
ICESat-2
June 2018
SMAP
Jan 2015
CYGNSS
EVM-1,
Oct 2016 LRD

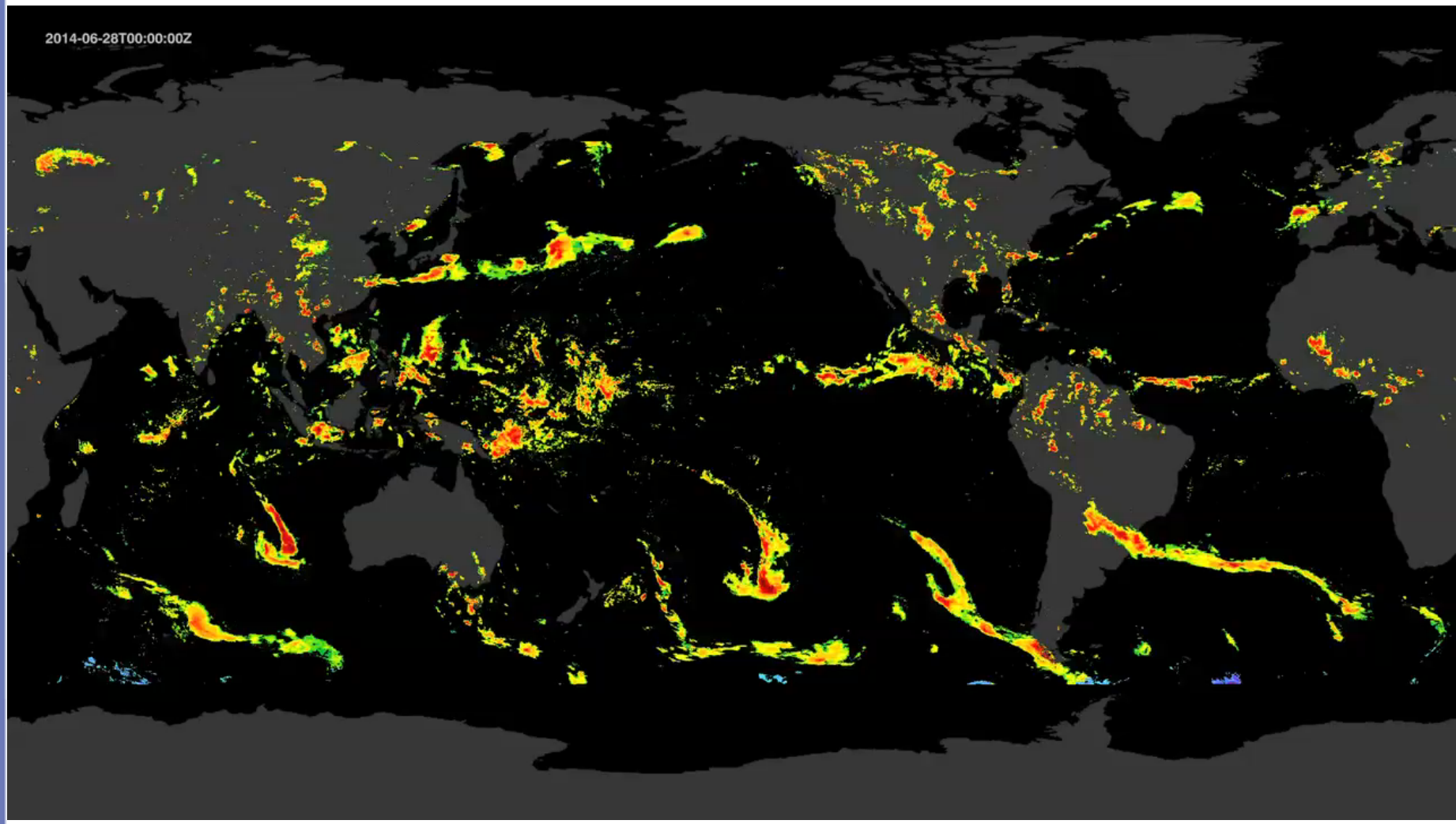
OCO-2 Level 2 Product Status

- OCO-2 Level 2 products (global column CO_2 (XCO2)) were released through GSFC DAAC at the end of March.
- The March 30th release also included solar-induced fluorescence (SIF) and updated L1b files. The L1b updates correcting known deficiencies including instrument artifacts (e.g. solar cosmic rays and a minor “clocking” of slit to FPA).
- A forward data stream arrived at the DAAC on March 30th, and backward processing at ~3x began shortly after. Forward data begins with March 19th. Backwards processing will extend to 9/6/14.
- The OCO-2 Science Team meeting was held Feb. 24 – 26th, 2015 in Pasadena. A broad cross section of the science team participated (118 in person, another 10 or so via webex).

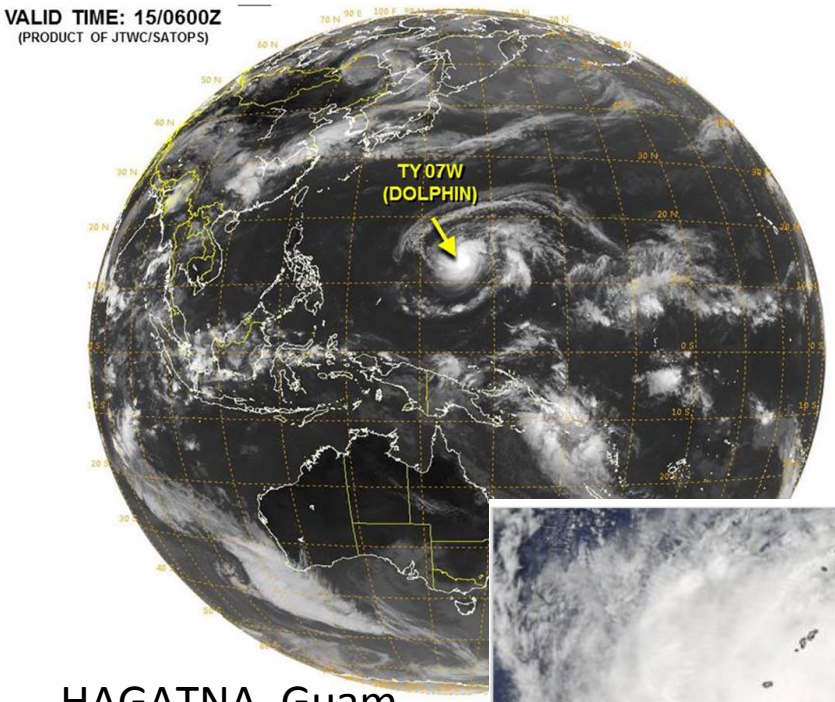
- The image to the right shows a sample of the OCO-2 solar-induced fluorescence retrievals using both nadir and glint observations from 21 Nov to 29 Dec.
- The Northern Hemisphere fall Is evident in the lack of plant activity and therefore solar-induced fluorescence.
- Spring plant activity is evident in the high solar induced fluorescence values over South America, sub-Saharan Africa, and Indonesia.
- Month by month time series are consistent with the changing seasons.

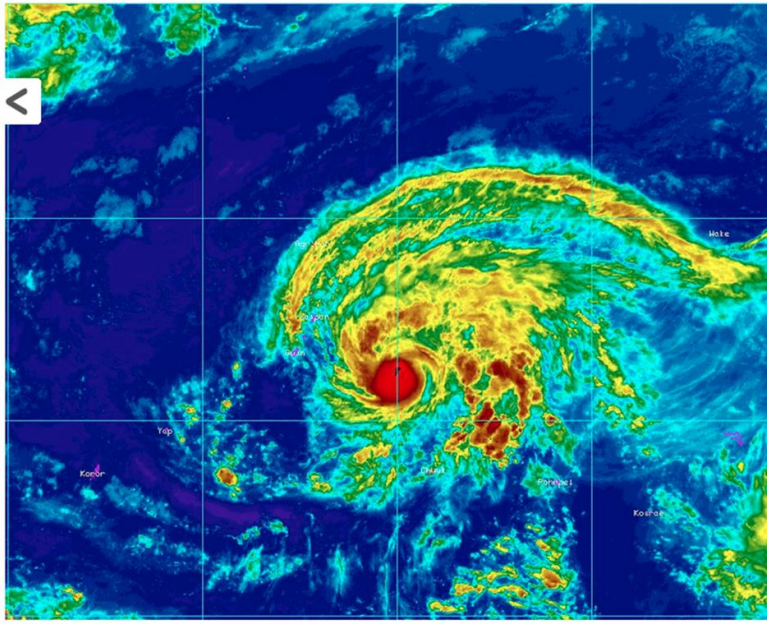


IMERG: Integrated Multi-satellitE Retrievals for GPM



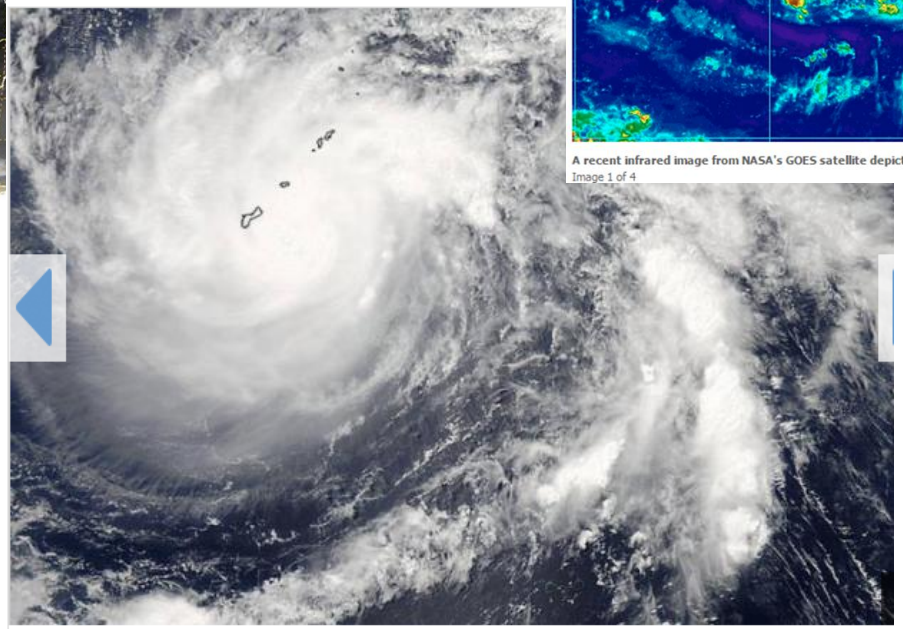
Typhoon Dolphin





A recent infrared image from NASA's GOES satellite depicting the structure.
Image 1 of 4

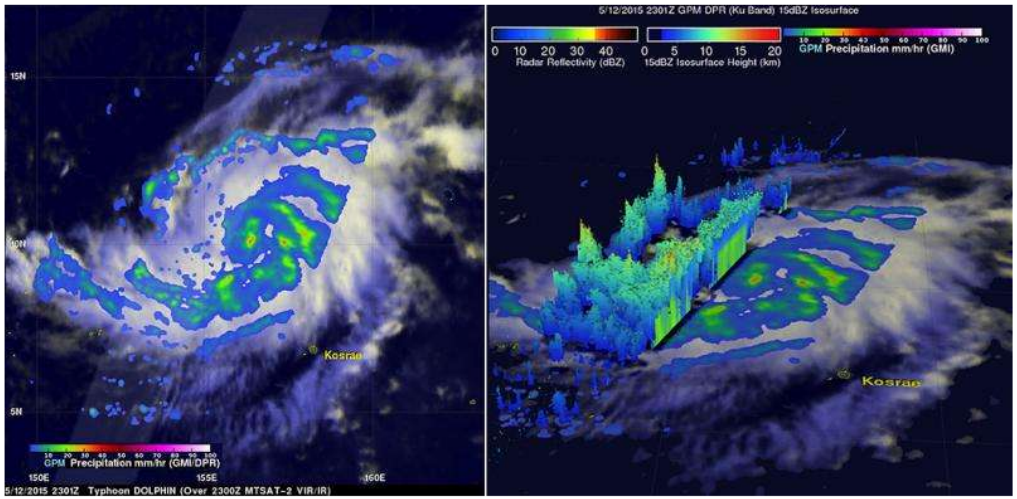
HAGATNA, Guam, May 15 (UPI) -- NASA's MODIS instrument recently captured Typhoon Dolphin hovering just north of Guam.



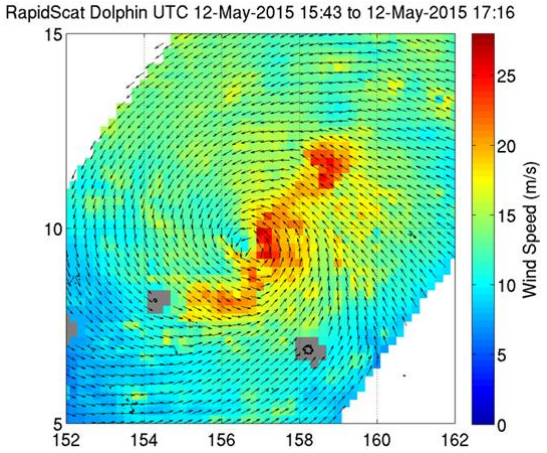
A natural-color image of Typhoon Dolphin passing just north of Guam. Photo by NASA Goddard MODIS Rapid Response Team

The storm passed across the Northern Marianas on Friday, sustaining winds of 109 miles per hour.

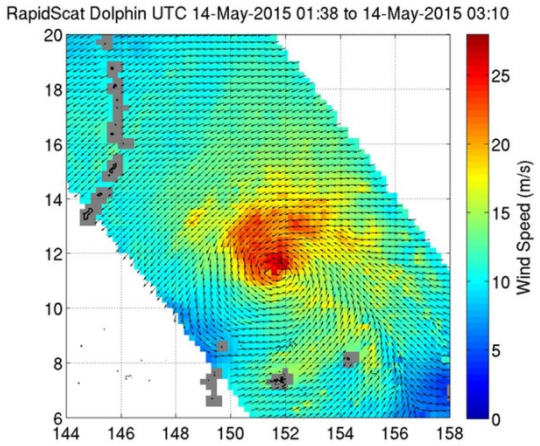
GPM / RAPIDSCAT / AIRS



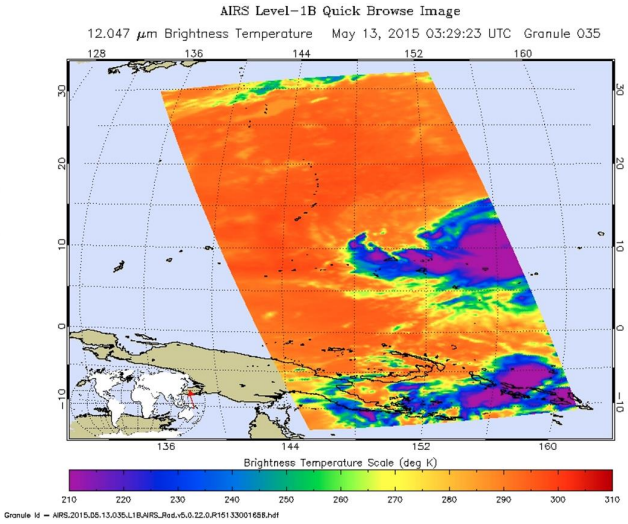
The Global Precipitation Measurement Mission took these images of Typhoon Dolphin on May 12, 2015. Credit: NASA/SSAI, Hal Pierce



RapidScat instrument on the International Space Station captured this image of Typhoon Dolphin on May 12, 2015 showing a very well-established spiral pattern in the storm



The RapidScat image taken on May 14, 2015 shows a very tight spiral of winds in the center which shows a very organized storm eye.



AIRS instrument image of Dolphin from May 13, 2015

Aqua/MODIS
2015/135
05/15/2015
03:25 UTC

Typhoon Dolphin (07W) in the Pacific Ocean

Pixel sizes:

2km
1km
500m
250m

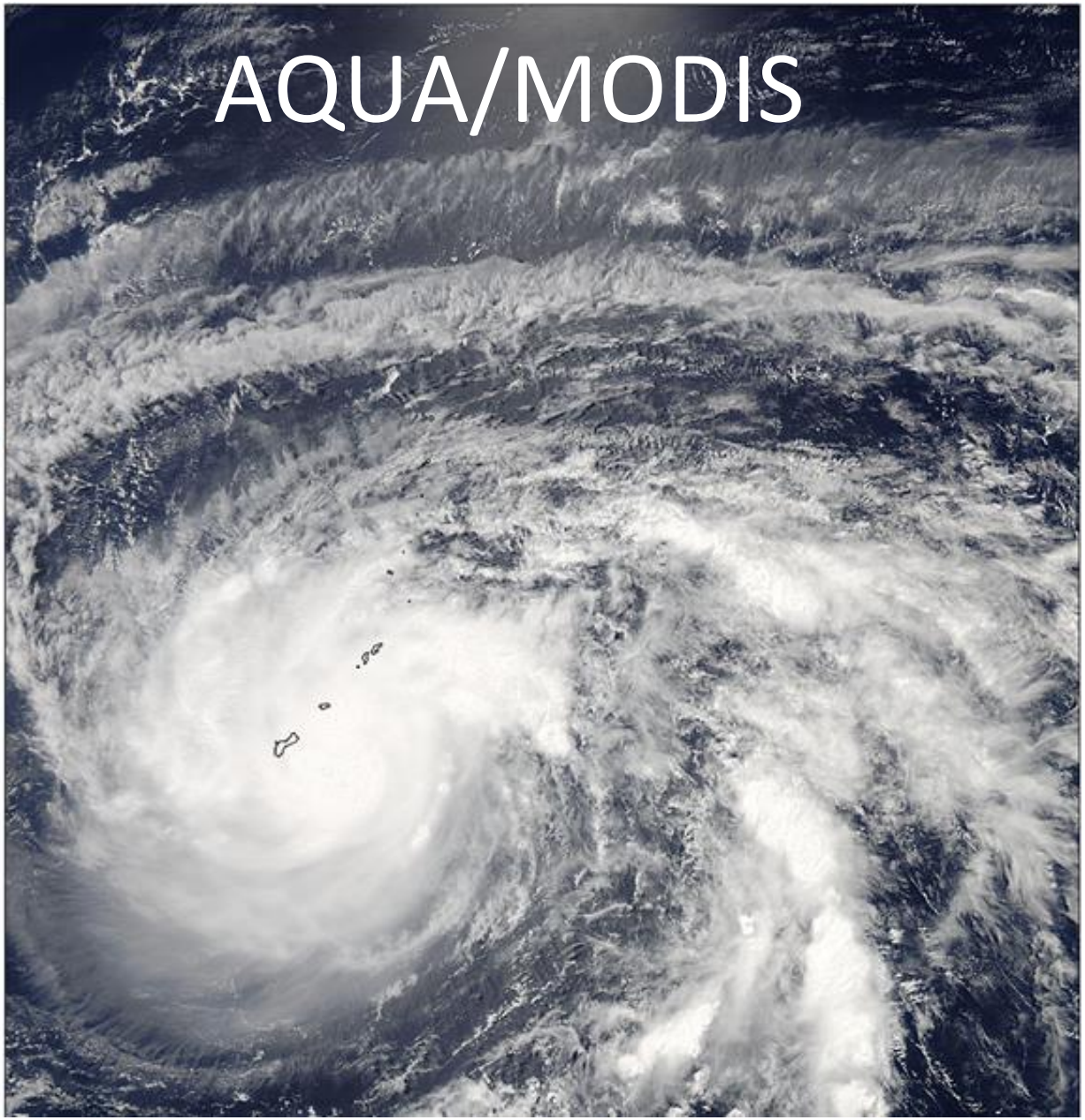
More information

View this region interactively with Worldview

Download a world file (for GIS)

Return to the image Gallery main page

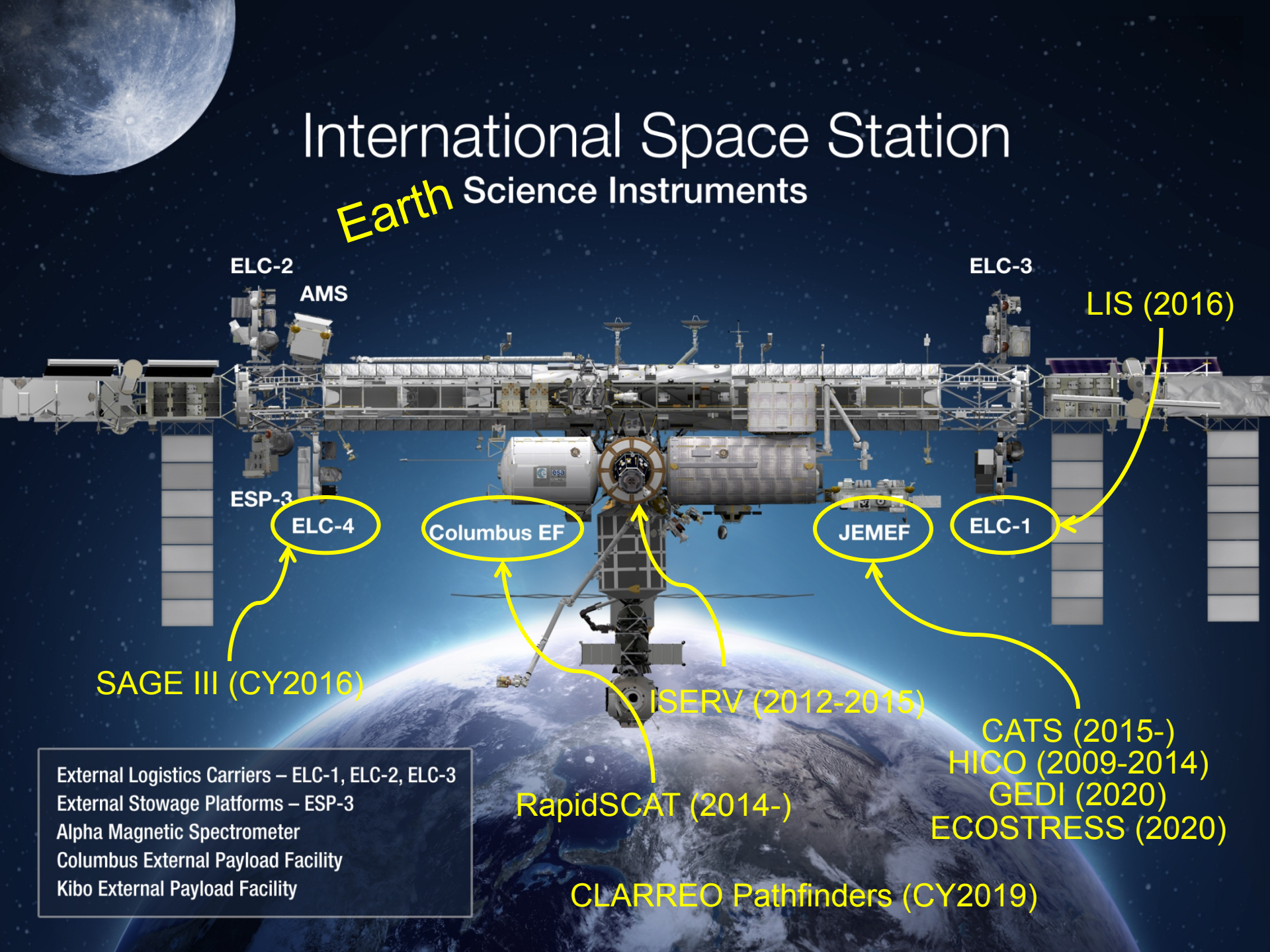
AQUA/MODIS



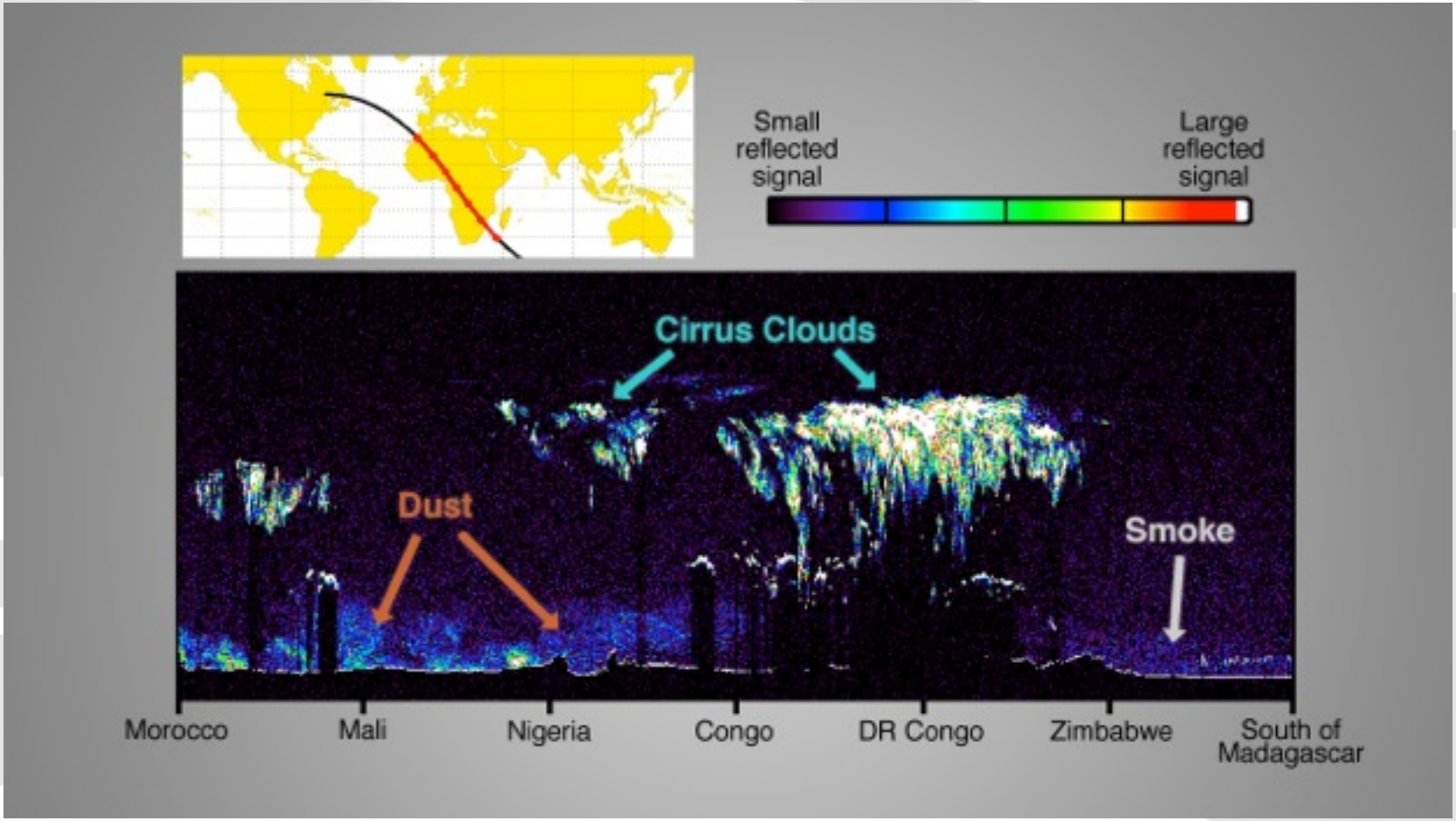
2015/135
05/15/2015
03:25 UTC

Update 5/17/2015

- Typhoon Dolphin is beginning to weaken and is now the equivalent of a Category 4 hurricane, as of Sunday morning mainland U.S. time. Dolphin reached its peak intensity as a Category 5 super typhoon on Saturday with top winds estimated to be 160 mph.
- Dolphin is now making its anticipated right turn, now moving northward instead of west-northwest.
- Dolphin will eventually round the western edge of a subtropical high-pressure system and begin to meet the mid-latitude upper-atmospheric westerlies. This will accelerate the typhoon toward the northeast, with steady weakening.
- While the typhoon will curve well east of the Japanese mainland, Dolphin may take a close swipe at Iwo To (Iwo Jima) on Tuesday, local time. Iwo Jima, famous for its role in World War II, is currently uninhabited except for military personnel.
- Dolphin's eye passed through the Rota Channel between Guam and Rota Island early Friday evening, local time, delivering the typhoon's strongest winds in the eyewall to both locations.
- Andersen Air Force Base on the northeast side of Guam clocked a peak wind gust of 106 mph just before 7 p.m. local time on Friday. Guam is 14 hours ahead of U.S. EDT. Just before 8 p.m. local time, Andersen AFB was reporting peak sustained winds of 84 mph in the southern eyewall of the typhoon.
- Rota Island, about 45 miles northeast of Guam, was hit by the northern eyewall of Dolphin. Storm chasers Jim Edds and James Reynolds are located there and sending reports. With a population of about 2,500, many of Rota's buildings are made of concrete.


International Space Station
Earth Science Instruments
ELC-2
AMS
ELC-3
LIS (2016)
ESP-3
ELC-4
Columbus EF
JEMEF
ELC-1
SAGE III (CY2016)
ISERV (2012-2015)
CATS (2015-)
HICO (2009-2014)
GEDI (2020)
ECOSTRESS (2020)
RapidSCAT (2014-)
CLARREO Pathfinders (CY2019)
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

Early CATS Image



The CATS image shows a profile of particles in the atmosphere over a swath of Africa, from 30 degrees North to 30 degrees South, as the space station flew over it in the early morning of Feb. 11.

Venture Class Selections/Solicitations

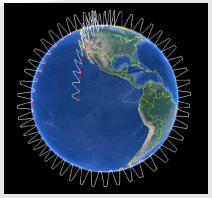
Mission	Mission Type	Solicitation Release	Proposal Selection	Major Milestone	Total Funding*
EVI-3	Instrument Only	Q2 FY2015	Q2 FY2016	Delivery NLT 2020	$130M
EVI-4	Instrument Only	Q4 FY2016	Q4 FY2017	Delivery NLT 2021	$150M
EVI-5	Instrument Only	Q2 FY2018	Q2 FY2019	Delivery NLT 2023	$182M
EVI-6	Instrument Only	Q4 FY2019	Q4 FY2020	Delivery NLT 2024	$155M
EVI-7	Instrument Only	Q2 FY2021	Q2 FY2022	Delivery NLT 2025	$185M
EVM-2	Full Orbital	Q3 FY2015	Q3 FY2016	Launch ~2021	$165M
EVM-3	Full Orbital	Q3 FY2019	Q3 FY2020	Launch ~2025	$179M
EVS-2	**Suborbital**	**Q4 FY2013**	**Q1 FY2015**	**2016-2020**	**$162M**
EVS-3	Suborbital	Q4 FY2017	Q4 FY2018	2019-2023	$176M

Most recent Selection

* Funding for future EVs is approximate and will be adapted depending on previous selections.

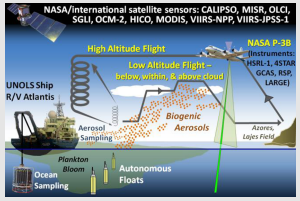
EVS-1: CARVE, ATTREX, DISCOVER-AQ, AirMOSS, HS-3
EVM-1: CYGNSS (2016 LRD)
EVI-1: TEMPO (2017 Instrument Delivery)
EVI-2: GEDI, ECOSTRESS (2019 Inst. Del.)
EVS-2: AtoM, NAAMS, OMG, ORACLES, ACT-America

Earth Venture Suborbital-2 (EV-2) Investigations



Atmospheric Tomography Experiment (ATom) – Harvard University (Steve Wofsy)

This investigation will study the impact of human-produced air pollution on certain greenhouse gases. Airborne instruments will look at how atmospheric chemistry is transformed by various air pollutants and at the impact on methane and ozone which affect climate. Flights aboard NASA's DC-8 will originate from the Armstrong Flight Research Center in Palmdale, California, fly north to the western Arctic, south to the South Pacific, east to the Atlantic, north to Greenland, and return to California across central North America.

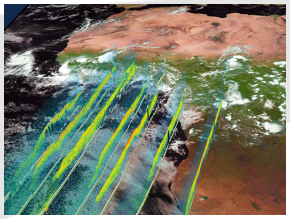


North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) – Oregon State U. (Mike Behrenfeld)

This investigation will improve predictions of how ocean ecosystems would change with ocean warming. The mission will study the annual life cycle of phytoplankton and the impact small airborne particles derived from marine organisms have on climate in the North Atlantic. The large annual phytoplankton bloom in this region may influence the Earth's energy budget. Research flights by NASA's C-130 aircraft from Wallops Flight Facility, Virginia, will be coordinated with a University-National Oceanographic Laboratory System (UNOLS) research vessel.

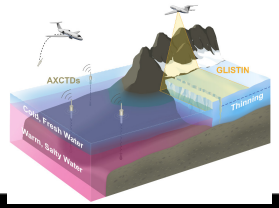
Atmospheric Carbon and Transport – America – Penn State University (Kenneth Davis)

This investigation will quantify the sources of regional carbon dioxide, methane and other gases, and document how weather systems transport these gases in the atmosphere. The research goal is to improve identification and predictions of carbon dioxide and methane sources and sinks using spaceborne, airborne and ground-based data over the eastern United States. Research flights will use NASA's C-130 from Wallops and the UC-12 from Langley Research Center in Hampton, Virginia.



ObseRvations of Aerosols Above Clouds and Their IntEractionS (ORACLES) – ARC (Jens Redemann)

ORACLES will probe how smoke particles from massive biomass burning in Africa influences cloud cover over the Atlantic. Particles from this seasonal burning that are lofted into the mid-troposphere and transported westward over the southeast Atlantic interact with permanent stratocumulus "climate radiators," which are critical to the regional and global climate system. NASA aircraft, including a Wallops P-3 and an Armstrong ER-2, will be used to conduct the investigation flying out of Walvis Bay, Namibia.

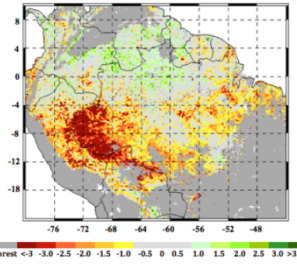


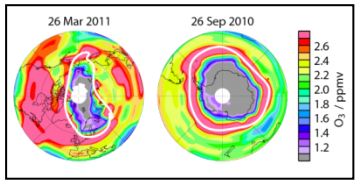
Oceans Melting Greenland (OMG) – JPL (Josh Willis)

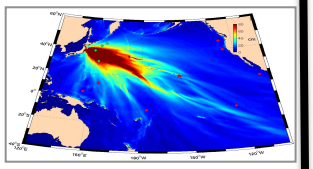
The objective of OMG is to investigate the role of warmer saltier Atlantic subsurface waters in Greenland glacier melting. The study will help pave the way for improved estimates of future sea level rise by observing changes in glacier melting where ice contacts seawater. Measurements of the ocean bottom as well as seawater properties around Greenland will be taken from ships and the air using several aircraft including a NASA S-3 from Glenn Research Center in Cleveland, Ohio, and Gulfstream III from Armstrong.

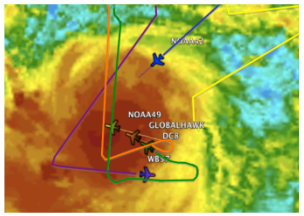
NASA's Earth Science Division

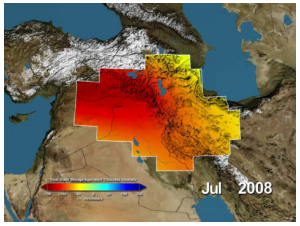
Research

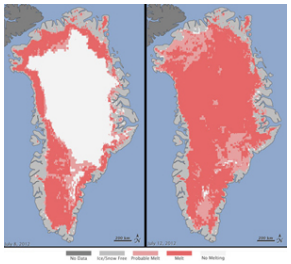




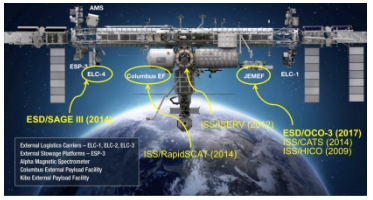




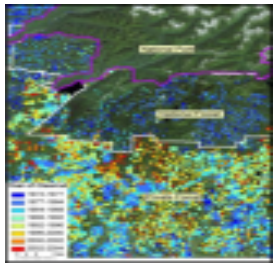


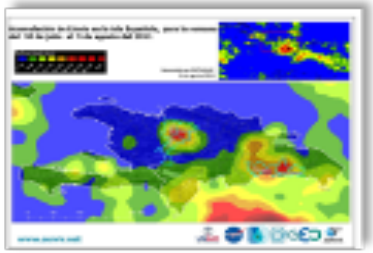


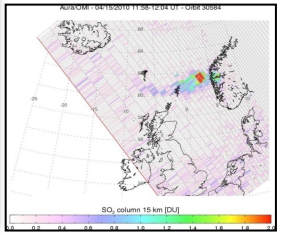
Flight

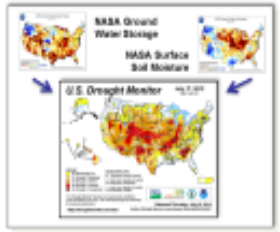


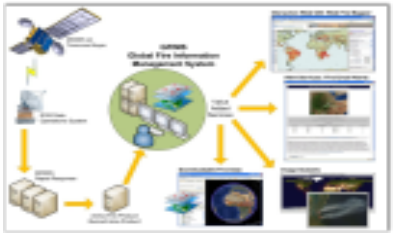
Applied Sciences

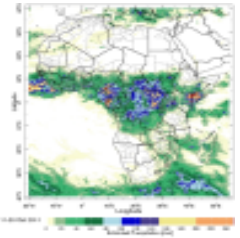




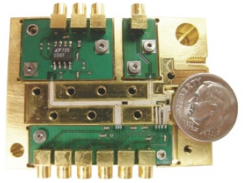








Technology



OVERALL SUMMARY (2 of 3)

- Earth Science Research

	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**399**	**432**	**417**	**425**	**418**	**414**
FY15		424	400	390	392	---

  - ✧ Includes funding to improve understanding of coupled North Atlantic-Arctic system
  - ✧ Includes additional funding for research to understand linkages between oceans and climate
  - ✧ Funds CDI, BEDI/GCIS, CRT/Citizen Science

- Applied Sciences

	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**40.4**	**47.6**	**48.7**	**48.4**	**47.6**	**48.8**
FY15		38.0	38.7	39.8	39.8	---

  - ✧ Will be used to accelerate ramp-up of Water and Food Security initiatives

OVERALL SUMMARY (3 of 3)

- Earth Science Technology Office

	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**59.7**	**60.7**	**62.1**	**61.5**	**61.2**	**62.7**
FY15		54.5	55.6	55.5	55.6	---

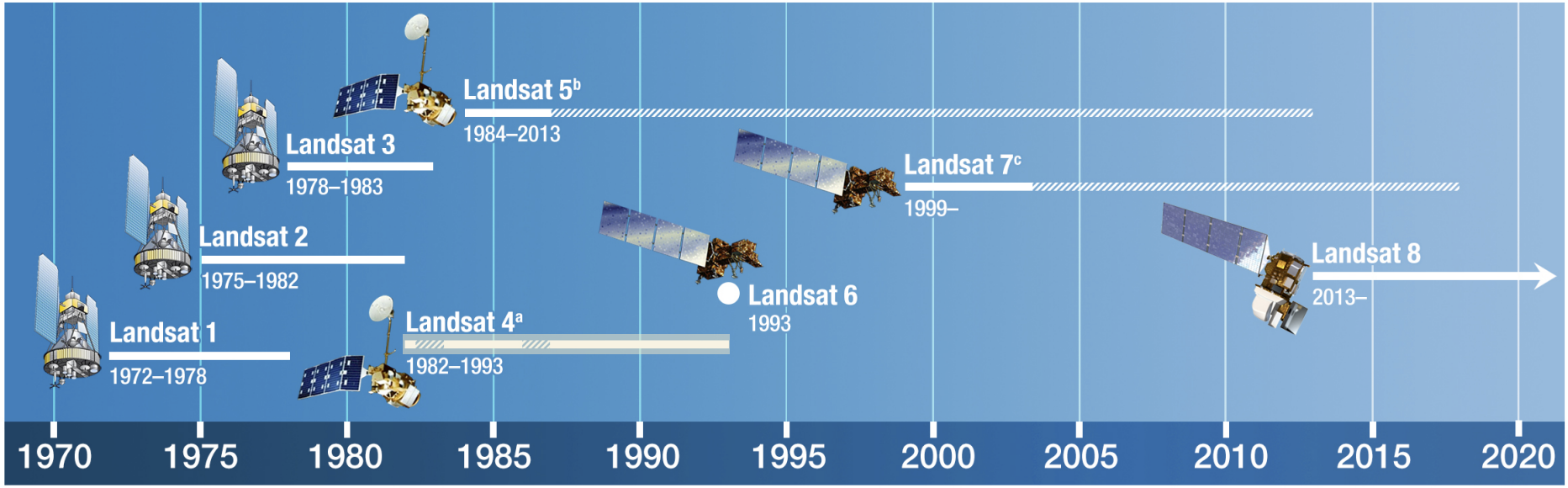
✧Increase for the InVEST program (~ $5M/year additional)


NASA

Long-term Measurement Mandate Missions

- Precision Altimetry following the launch of Jason-3
  - FY16-20 budget supports NASA contributions to Jason-CS
    - LV, radiometer, laser retroreflector; etc. NASA funding for mission ops and data analysis; 2020 launch
  - Continued development of SWOT (2020 launch)
- Solar Irradiance
  - TSIS-2 and beyond transferred to NASA in FY14
  - FY16-20 budget supports completion of TSIS-1 and flight on ISS, LRD August 2017
    - Recognizes NOAA FY15 appropriation for TSIS-1
- Earth Radiation Balance (RBI instrument)
  - RBI continues to be developed by NASA for flight on JPSS-2

Landsat History



[a]Limited data due to transmitter failure soon after launch. Only 45,172 Landsat 4 Thematic Mapper scenes from 1982–1993 available for science users—~10 scenes/day (vs 725 scenes/day from L8)

[b]Data coverage limited to Continental US (CONUS) and International Ground Station sites after a transmitter failure in 1987; Multispectral Scanner turned off in August 1995

[c]Degraded Performance due to Scan Line Corrector failure in May 2003

- The Landsat program began as the Earth Resources Technology Satellites Program in 1966, with Landsat 1 (ERTS) launched in July 1972
- NASA built and launched Landsats 1-5 and Landsats 7-8
- Thermal band added for Landsats 3 and beyond
- After launch, Landsat operations are transferred from NASA to USGS, and USGS collects, archives, processes, and distributes the image data via the internet at no cost to users
- Landsat 8 began as a data purchase and became known as the Landsat Data Continuity Mission (LDCM)
    - Although the thermal bands were originally not incorporated in the mission, they were added back into the Observatory's capabilities following strong support from a variety of stakeholders

SLI in FY16 President's Budget Submit

A multi-component program, with the essential investments in technology and observational innovation to ensure a world class, sustainable, and responsible land imaging program through 2035:

1. TIR-FF (Class D Thermal Infrared Free Flyer) to launch ASAP (no later than 2019) and to fly in constellation with a reflective band imager like OLI on L-8
   - Low-cost mitigation against an early loss of the Landsat 8 Class C TIRS, while demonstrating feasibility of constellation flying for land imaging

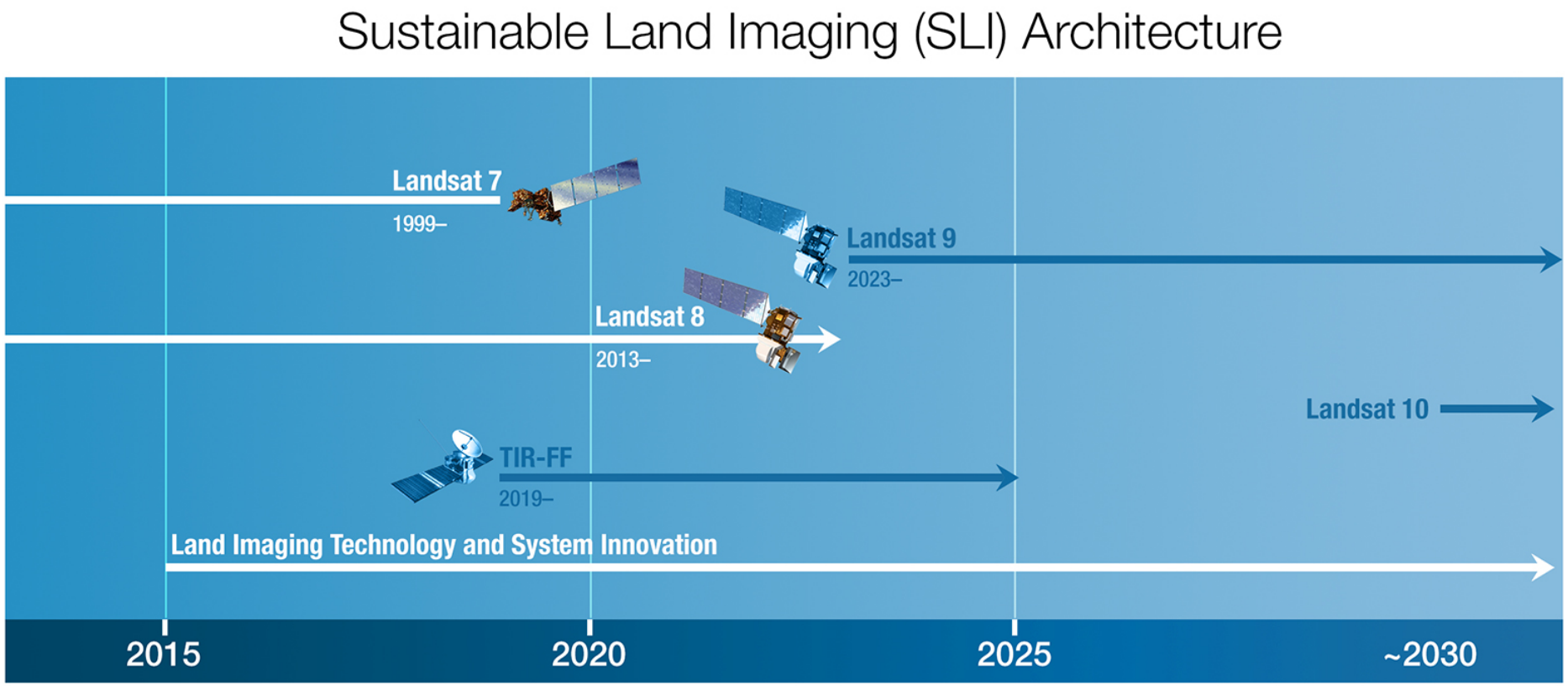
2. Landsat 9 (Class B upgraded rebuild of Landsat 8) to launch in 2023
   - Low programmatic risk implementation of a proven system with upgrades to bring the whole system to Class B

3. Land Imaging Technology and Systems Innovation
   - Hardware, operations and data management/processing investments to reduce risk in next generation missions.

4. Landsat 10
   - Mission definition to be informed by the Technology investments, leading to key mission configuration/architecture decisions by the end of the decade

NASA Budget for Sustainable Land Imaging	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
	$30,000	$64,100	$78,900	$134,600	$174,400	$179,900	$147,300

Landsat Future



Thermal IR Free Flyer, TIR-FF

The primary objective is to provide an alternate source of thermal IR imagery by 2019 - specifically in advance of the TIR channels provided on Landsat 9 (2023 launch date).

- Thermal IR measurements provide unique, precise information on water use (primarily for crop irrigation) and urban heating
- Studies have indicated that the TIR measurements are at the greatest risk of continuity because (1) the L8 TIRS has only a 3-year design life; (2) stray light and hardware issues have already degraded the reliability and performance of the L8 TIRS; and (3) the EU Sentinel satellites do not include thermal channels
- TIR-FF will fly in constellation with another land imaging satellite, likely Landsat 8 or Sentinel-2

The TIR-FF development is assigned to NASA/GSFC for implementation

- Small satellite
- Simple instrumentation
- Dedicated small launch vehicle

TIR-FF will follow a Class D implementation to ensure rapid development, with a launch targeted for 2019

Landsat 9

The Landsat 9 mission: a near-repeat build of the LDCM/Landsat 8 system, upgraded to full Class B, to launch in 2023.

- Ensures the baseline Landsat data record is continued into the late 2020s with minimal programmatic and technical risk
- The ground system is fully defined, needing incremental additions only

Rebuild based on the successful Landsat 8 observatory, with specific modifications:

- The Landsat 9 TIRS instrument would be upgraded to full Class B configuration (5-year design life; in-house NASA/GSFC build)
- Spacecraft competed and modified as required to accommodate upgraded TIRS
- Commercial management/oversight practices explored for cost savings at acceptable risk

Technology and Systems Innovation

Persistent investment in technology and observational innovation is essential for a world class, sustainable, and responsible land imaging program.

- The Plan includes a budget for technology and systems innovation that rises to ~5% of the total SLI budget line.

At the **component/technology** level examples of specific investigations include:

- Focal plane technology to support wide swath, moderate resolution imagery for multispectral and hyperspectral instruments; ***Underway***
- Hyperspectral thermal measurements; ***Underway***

At the **system** level, examples of specific technical investigations include:

- Instrument miniaturization approaches to meet program observing objectives with smaller, less expensive satellites; ***Underway***
- Integrated instrument approaches combining VISNIR and TIR channels

At the **programmatic** level, examples of specific investigations include:

- Commercial and hybrid commercial/governmental procurement and management approaches; ***Underway***
- Integration of multiple data sets from an open array of satellite observations to create a seamless land imaging archive for the user, including TIR-FF + Landsat 8 or + Sentinel 2 ***Underway with ROSES (NASA's competitive research program) solicitation/selections***

Near-term work will inform the Landsat 10 configuration decision (L10 development to start in early 2020's)

Land Imaging in FY15 Senate Approps Report

Senate FY 2015 Report:

Landsat Data Continuity.—The Committee provides $68,100,000, $4,000,000 above the request, for a land imaging mission successor to Landsat 8. With Landsat 7 at risk for ending its mission life as early as 2017, the Committee is deeply troubled at the potential loss of 8-day continuous terrestrial coverage now provided through the Landsat satellite series. **The Committee does not concur with various administration efforts to develop alternative "out of the box" approaches to this data collection—whether they are dependent on commercial or international partners.** Given the constraints in Federal funding, and the absence of credible alternatives to a conventional land imaging mission that ensures Landsat data continuity**, NASA should proceed with an acquisition in fiscal year 2015 for a mission to launch a follow on to Landsat 8 by not later than 2020 that does not exceed a cost cap of $650,000,000, inclusive of all launch vehicle costs.** Such a mission shall maximize the utilization of non-recurring engineering efforts from Landsat 8 to maintain a relatively low level of project risk. In addition, as a follow on to Landsat 8, *program reserves shall be limited to not more than 10 percent for the duration of the mission's development and all hardware contracts should be firm fixed price and reflect steep discounts over the price paid for comparable components for Landsat 8*. The Committee notes that the notional land imaging fiscal year 2016 budget is now more than $100,000,000 below what is needed for a 2020 launch. Hence, the Committee expects the 2016 budget to reflect resources necessary to meet that launch date.

Land Imaging in FY15 Appropriation

FY 2015 Appropriations Explanatory Statement

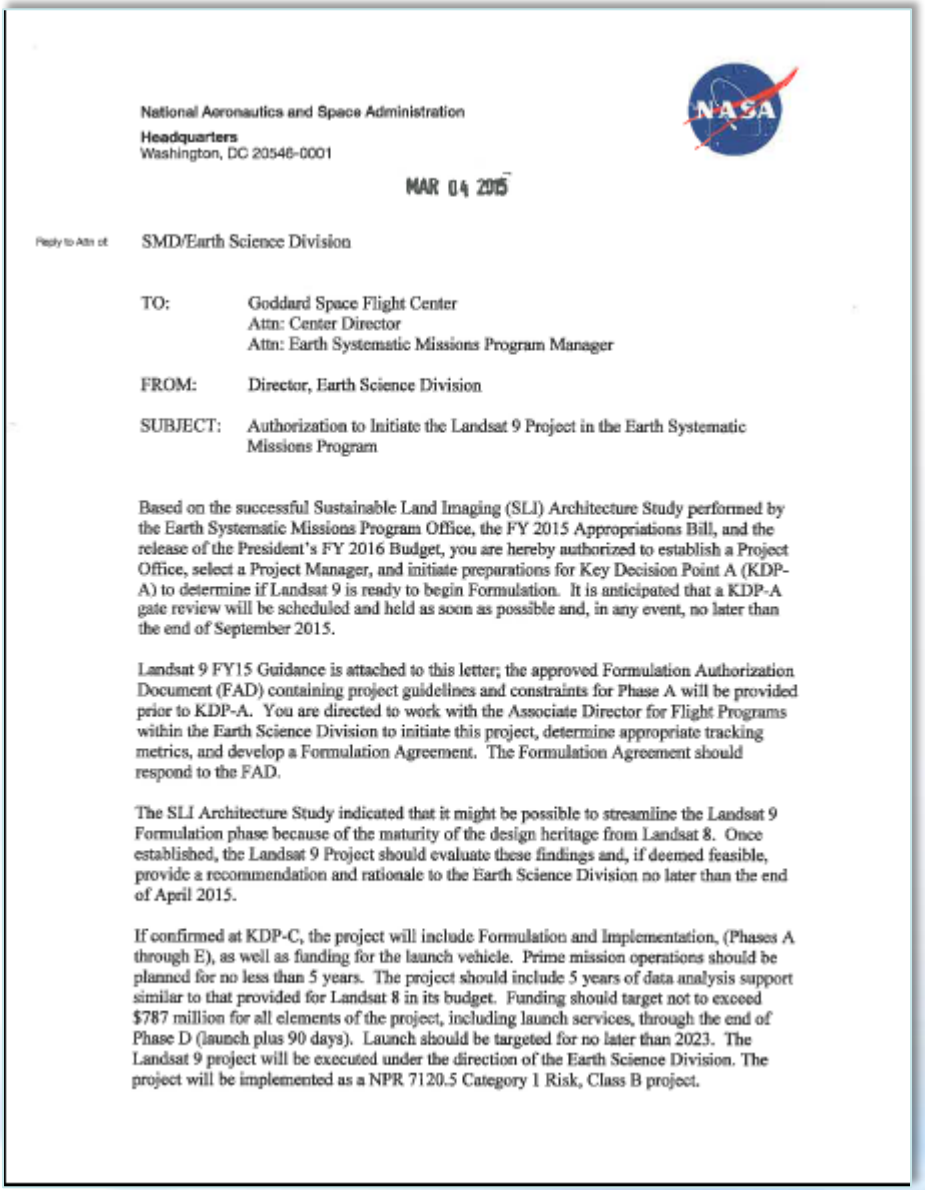
The agreement supports Senate direction on Landsat Data Continuity, but provides the requested amount of $64,100,000 and clarifies Senate direction on development parameters. Instead of a firm cost cap boundary, the mission shall:

- cost substantially less than Landsat-8;
- provide the same data quality as Landsat-8 so as to not require an overhaul of associated ground systems; and
- provide no degradation or gap in data including the 8-day continuous terrestrial coverage.

The agreement does not endorse any efforts to develop alternative approaches to this data acquisition that would increase risk of a coverage gap and not meet the needs of the Landsat user community.

Sustainable Land Imaging: Landsat 9

Landsat 9 Project Authorization Letter



National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

MAR 04 2015

Reply to Attn of: SMD/Earth Science Division

TO: Goddard Space Flight Center
Attn: Center Director
Attn: Earth Systematic Missions Program Manager

FROM: Director, Earth Science Division

SUBJECT: Authorization to Initiate the Landsat 9 Project in the Earth Systematic Missions Program

Based on the successful Sustainable Land Imaging (SLI) Architecture Study performed by the Earth Systematic Missions Program Office, the FY 2015 Appropriations Bill, and the release of the President's FY 2016 Budget, you are hereby authorized to establish a Project Office, select a Project Manager, and initiate preparations for Key Decision Point A (KDP-A) to determine if Landsat 9 is ready to begin Formulation. It is anticipated that a KDP-A gate review will be scheduled and held as soon as possible and, in any event, no later than the end of September 2015.

Landsat 9 FY15 Guidance is attached to this letter; the approved Formulation Authorization Document (FAD) containing project guidelines and constraints for Phase A will be provided prior to KDP-A. You are directed to work with the Associate Director for Flight Programs within the Earth Science Division to initiate this project, determine appropriate tracking metrics, and develop a Formulation Agreement. The Formulation Agreement should respond to the FAD.

The SLI Architecture Study indicated that it might be possible to streamline the Landsat 9 Formulation phase because of the maturity of the design heritage from Landsat 8. Once established, the Landsat 9 Project should evaluate these findings and, if deemed feasible, provide a recommendation and rationale to the Earth Science Division no later than the end of April 2015.

If confirmed at KDP-C, the project will include Formulation and Implementation, (Phases A through E), as well as funding for the launch vehicle. Prime mission operations should be planned for no less than 5 years. The project should include 5 years of data analysis support similar to that provided for Landsat 8 in its budget. Funding should target not to exceed $787 million for all elements of the project, including launch services, through the end of Phase D (launch plus 90 days). Launch should be targeted for no later than 2023. The Landsat 9 project will be executed under the direction of the Earth Science Division. The project will be implemented as a NPR 7120.5 Category 1 Risk, Class B project.

Pre-Aerosol, Cloud, and ocean Ecosystem (PACE) Mission

Pre-Aerosol, Cloud, and ocean Ecosystem (PACE) is an ocean color, aerosol, and cloud mission identified in the 2010 report "Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space Science".

Science Objectives

- **Primary:** Understand and quantify global biogeochemical cycling and ecosystem function in response to anthropogenic and natural environmental variability and change: **ocean color sensor**
- **Secondary:** Understand and resolve/quantify the role of aerosols and clouds in physical climate (the largest uncertainty): **polarimeter**
- Extend key Earth system data records on global ocean ecology, biogeochemistry, clouds, and aerosols (expanded ocean color sensor similar to MODIS)

Risk	• 8705.4 Payload Risk Class C
Launch	• 2022/2023, budget and profile driven
Orbit	• 97° inclination; ~650 km altitude; sun synchronous
Duration	• 3 years
Payload	• Ocean color instrument; potential for a polarimeter
LCC	• **$805M Cost Cap**

PACE Cost Cap

Cap is $805M and includes the following:

- Project team at GSFC (to include PM, SE, & SMA functions)
- Spacecraft bus
- Launch vehicle
- Instrument payload
- 3 years of mission operations
- Project-held UFE
- Data processing/analysis to be performed by GSFC's Ocean Biology Processing Group (OBPG)
- Mission Science
  - Calibration/validation (hardware and conducting cal/val)
  - Science team support (development phase and post launch)