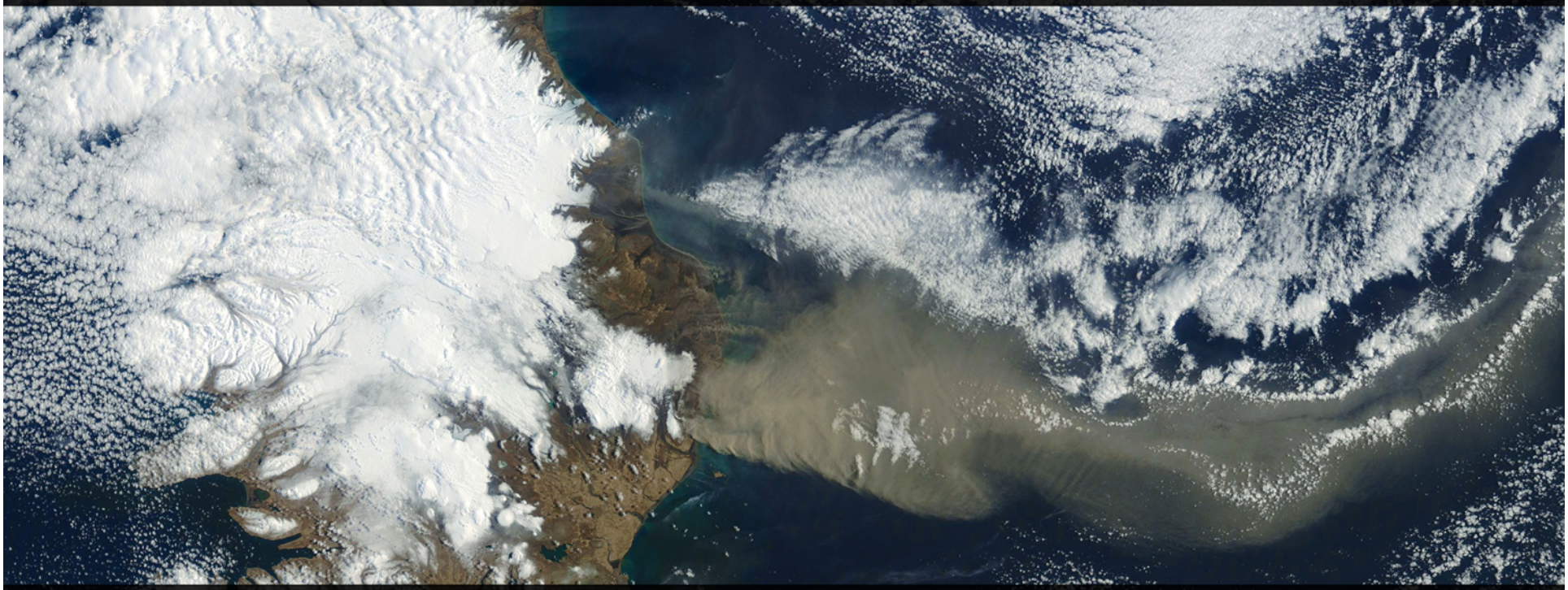
National Aeronautics and Space Administration

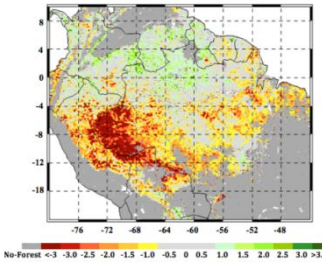


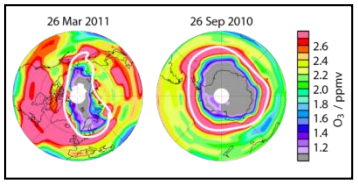
Earth Science

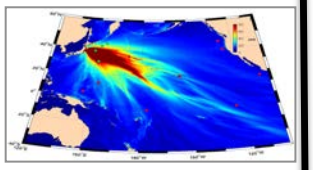
FY16-17 Overview/Summary
MODIS Science Team Meeting
June 2016

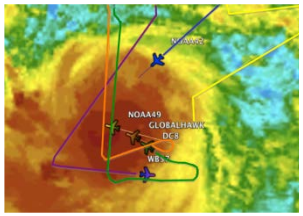
NASA's Earth Science Division

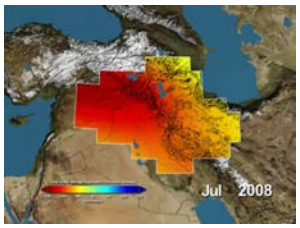
Research

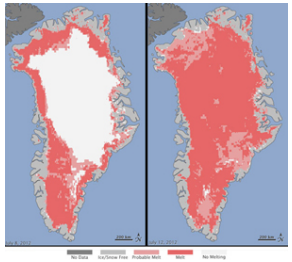




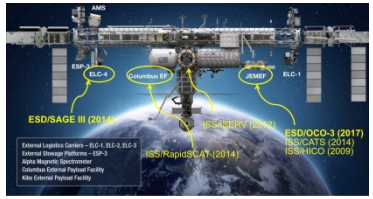




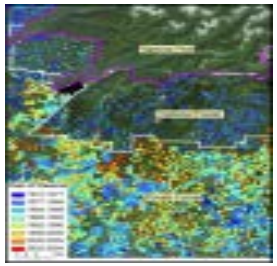


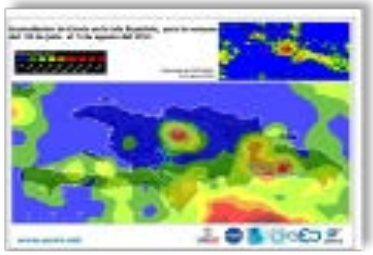


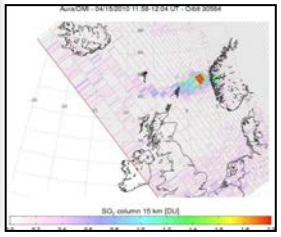
Flight

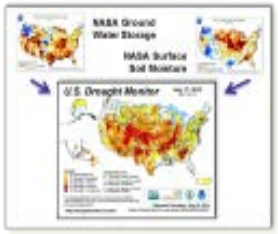


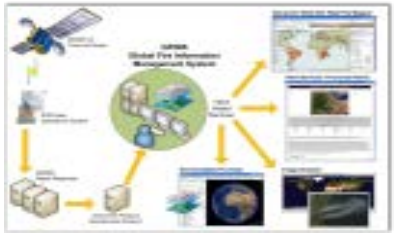
Applied Sciences

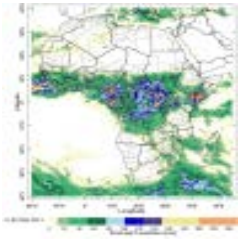




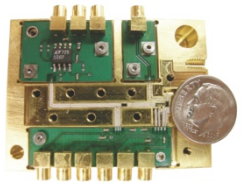








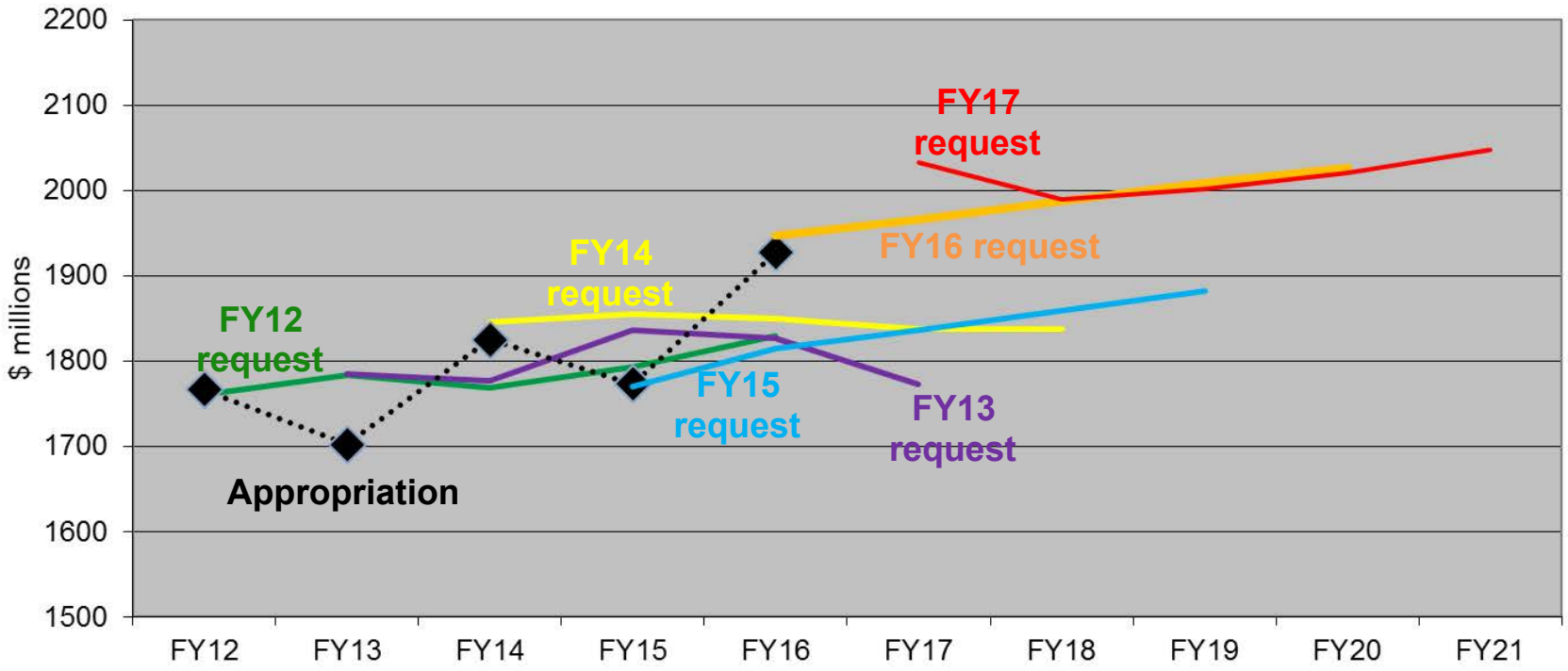
Technology

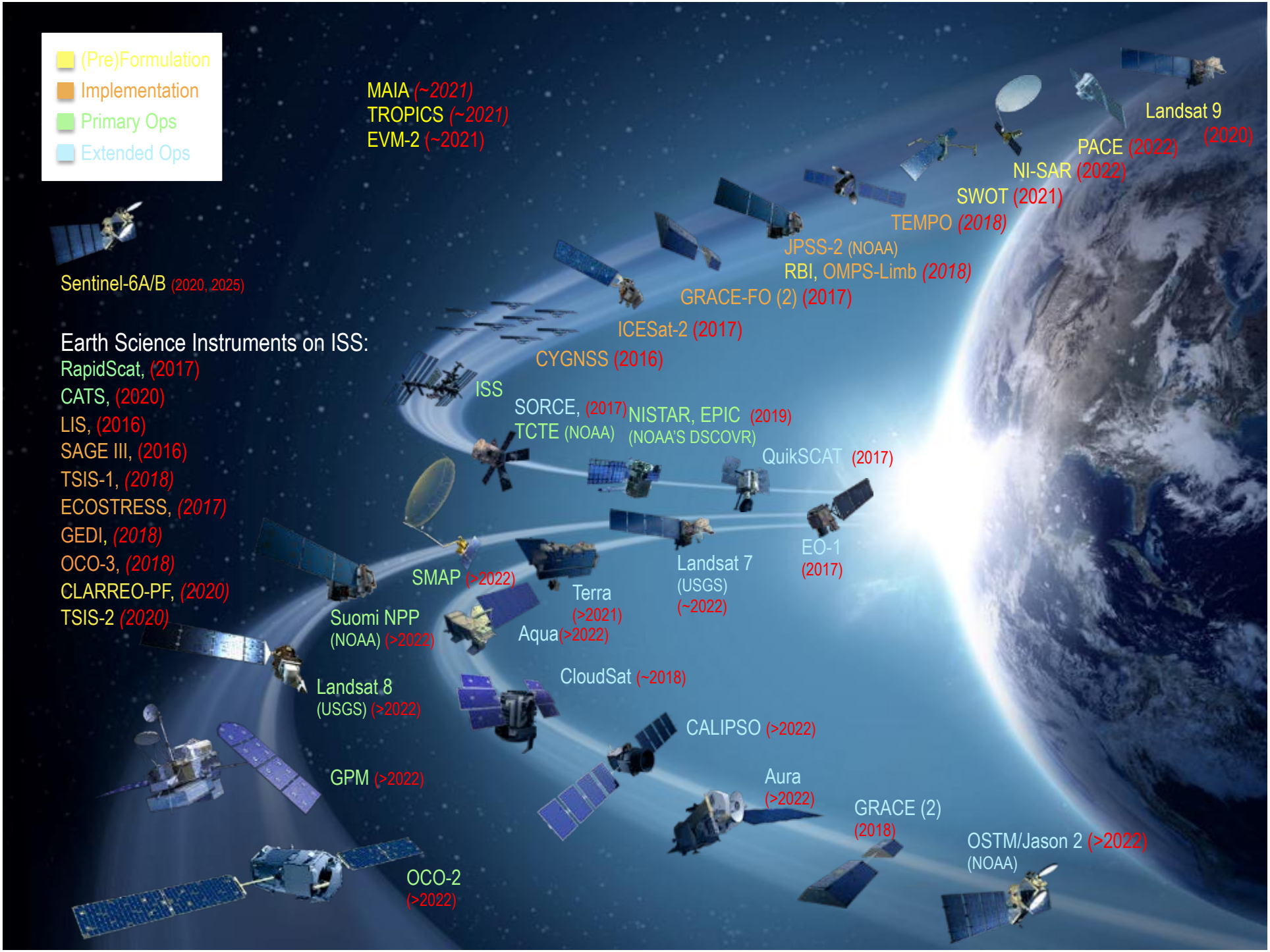


ESD Budget: FY17 Request/Appropriation

ESD Total						
$M	**FY16 (op plan)**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**
FY16 PBS	$ 1,927	$ 1,966	$ 1,988	$ 2,009	$ 2,027	
FY17 PBS		$ 2,032	$ 1,990	$ 2,001	$ 2,021	$ 2,048

- *ESD budget jumps significantly in FY17 – then becomes consistent with FY16 President's Budget Request for the out-years*




(Pre)Formulation
Implementation
Primary Ops
Extended Ops
MAIA (~2021)
TROPICS (~2021)
EVM-2 (~2021)
Sentinel-6A/B (2020, 2025)
Earth Science Instruments on ISS:
RapidScat, (2017)
CATS, (2020)
LIS, (2016)
SAGE III, (2016)
TSIS-1, (2018)
ECOSTRESS, (2017)
GEDI, (2018)
OCO-3, (2018)
CLARREO-PF, (2020)
TSIS-2 (2020)
Landsat 9 (2020)
PACE (2022)
NI-SAR (2022)
SWOT (2021)
TEMPO (2018)
JPSS-2 (NOAA)
RBI, OMPS-Limb (2018)
GRACE-FO (2) (2017)
ICESat-2 (2017)
CYGNSS (2016)
ISS
SORCE, (2017)
TCTE (NOAA)
NISTAR, EPIC (2019)
(NOAA'S DSCOVR)
QuikSCAT (2017)
EO-1
(2017)
Landsat 7
(USGS)
(~2022)
SMAP (>2022)
Terra
(>2021)
Aqua(>2022)
Suomi NPP
(NOAA) (>2022)
CloudSat (~2018)
Landsat 8
(USGS) (>2022)
CALIPSO (>2022)
GPM (>2022)
Aura
(>2022)
GRACE (2)
(2018)
OSTM/Jason 2 (>2022)
(NOAA)
OCO-2
(>2022)

ESM and ESSP Program Overviews

- The Earth Systematic Missions (ESM) ***development*** missions in this period include:
  - ICESat-2, SAGE III, GRACE-FO, SWOT, Landsat-9, RBI, TSIS-1 and -2, OMPS-Limb, NISAR, PACE, Sentinel 6A and -B, CLARREO Pathfinder
- The Earth Systematic Missions (ESM) ***on-orbit**** missions include:
  - SMAP (>2022), DSCOVR (2019), S-NPP (>2022), GPM (>2022), LDCM (>2022), Terra (>2022), Aqua (>2022), Aura (>2022), OSTM (>2022), QuikScat (2017), SORCE (2017), and EO-1 (2017); also RapidScat (2017) and CATS (2020)

- The Earth System Science Pathfinder (ESSP) ***development*** missions in this period include:
  - OCO-3, CYGNSS, TEMPO, GEDI, ECOSTRESS, MAIA, TROPICS
  - EVS-2 and -3 and Venture Technology selections (GrAOWL, Tempest), EVM-2 & 3, EVI-4,5,6,7,8
- The Earth System Science Pathfinder (ESSP) ***on-orbit*** missions include:
  - OCO-2 (>2022), GRACE (2018), CALIPSO (>2022), CloudSat (2018)

**On-orbit dates correspond to end-of-mission assumptions, consistent with 2015 Sr. Review*

Venture Class Selections/Solicitations

Mission	Mission Type	Release Date	Selection Date	Major Milestone
EVM-2	Full Orbital	FY15	FY16	Launch ~2021
EVI-4	Instrument Only	FY16	FY17	Delivery NLT 2021
EVS-3	Suborbital Airborne Campaigns	FY17	FY18	N/A
EVI-5	Instrument Only	FY18	FY19	Delivery NLT 2023
EVM-3	Full Orbital	FY19	FY20	Launch ~2025
EVI-6	Instrument Only	FY19	FY20	Delivery NLT 2024
EVI-7	Instrument Only	FY21	FY22	Delivery NLT 2026
EVS-4	Suborbital Airborne Campaigns	FY21	FY22	N/A
EVI-8	Instrument Only	FY22	FY23	Delivery NLT 2024

Open solicitation
Completed solicitation

EVS-1: CARVE, ATTREX, DISCOVER-AQ, AirMOSS, HS-3

EVM-1: CYGNSS (10/2016 LRD)

EVI-1: TEMPO (2019-; 2017 instrument delivery)

EVI-2: GEDI (2019; 2018 del.); ECOSTRESS (10/2017; 5/2017 del.)

EVS-2: ATom, NAAMES, OMG, ORACLES, ACT-America, CORAL

EVI-3: MAIA, TROPICS

EVM-2: *Selection(s) likely by end of FY2016*

Earth Science Research

Focus Areas

Carbon cycle and Ecosystems

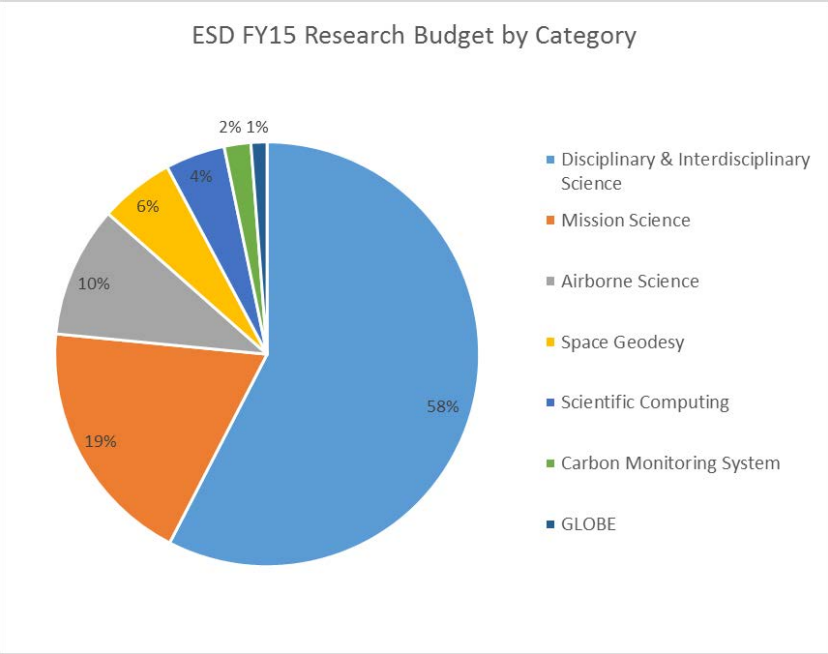
Climate Variability and Change

Atmospheric Composition

Global Water and Energy Cycle

Earth Surface and Interior

Weather



Mission	Location(s)	Date(s)	Platform(s)	Summary of Mission
Aviris NG India	Hyderabad India	Dec 15 – Spring 16	B200 (ISRO aircraft)	Imaging spectroscopy science and application investigation over Indian territory
AfriSAR/G-TEC	Gabon Africa	Feb – Mar 16	B200, C20A	NASA/ESA collaboration on algorithm development and future mission cal/val activities for above-ground biomass and ecosystem structure and dynamics usint radar and lidar.
Korus-AQ	Korea	Spring 16	DC8, B200	Study sources of pollution in atmosphere over Korea and Western Pacific region using a mix of in situ and remote sensing capability while enhancing understanding of future geostationary atmospheric composition observations
Atmospheric Carbon and Transport – America	Eastern and Midwestern US	Summer 16, Spring 17, Fall 17, Summer 18	B200, C-130	Quantify the sources of regional carbon dioxide, methane and other gases, and document how weather systems transport these gases in the atmosphere; improve identification and predictions of carbon dioxide and methane sources and sinks over the eastern US
North Atlantic Aerosols and Marine Ecosystems Study (NAAMES)	Atlantic Ocean, flown from Canada	Sep 17, Mar/Apr 18,	C-130, Ship ((UNOLS) research vessel)	Environmental and ecological controls on plankton communities in the North Atlantic Ocean
Coral Reef Airborne Laboratory (CORAL)	FL, HI, Mariana Is., Palau, Australia	Apr 16 – Jan 17	Contracted GIV	Provide critical data and new models needed to analyze the status of coral reefs and to predict their future
ObseRvations of Aerosols Above Clouds and Their IntEractionS (ORACLES)	Namibia, Africa	Aug/Sep 16, Jul/Aug 17, Sep/Oct 18	P-3, ER-2	Investigate how smoke particles from massive biomass burning in Africa influences cloud cover over the Atlantic.
Oceans Melting Greenland (OMG)	Greenland	Sep/Oct 16 - + multiple till Sept/Oct 2019	Contracted Twin Otter, GIII, Ship (MV Cape Race)	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.
Atmospheric Tomography Experiment (ATom)	Around the Globe	Aug 16, Jan/Feb 17, Sep/Oct 17, Apr/ May 18	DC-8	Study the impact of human-produced air pollution on multiple greenhouse gases, addressing transformation of various air pollutants, especially methane and ozone.
O2/N2 Ratio and CO2 Airborne Southern Ocean (ORCAS)	Southern Ocean	Jan/Feb 16	GV (NSF)	NASA brings remote sensing (PRISM) capability to NSF-led mission to Investigate the large-scale tropospheric distributions, gradients, and fluxes of O2 and CO2 over Southern Ocean.
HyspIRI	Hawaii	Summer 16	ER-2	Study the optical characteristics of coral reef and volcanic systems in and around Hawaii using MASTER and AVIRIS to assess value of HysPIRI-like observations
Operation IceBridge	Alaska, Greenland, Antarctica	Mar – May, Oct/Nov – FY16,17,18,19	P-3, DC-8	Study ice sheet thickness, sea ice distributions, and related parameters over Arctic and Antarctic to bridge gap between ICESat-1 and ICESat-2, complement lidar observations with those using related techniques (e.g., radar) and obtain coincident data with ESA CryoSat-2
UAVSAR	Various US and South America	Year round	C-20	Radar data collected for multiple NASA focus areas (Earth Surface and Interior, Carbon Cycle and Ecosystems, Global Water and Energy Cycle, Climate Variability and Change) and for Applications Uses (e.g., levee monitoring)
SPURS II	Eastern Sub-Tropical Pacific Ocean	Starting spring 2016, multiple sailings covering 18 month period	Schooner Lady Amber plus in-water observations (e.g., gliders, drifters, buoys)	Study processes that control sea surface salinity in higher salinity region than that sampled in SPURS I (sub-tropical North Atlantic)
ABoVE	Alaska, NW Canada	Beginning 2016, continuing	Surface measurements; airborne to follow	Study vulnerability and resilience of Arctic ecosystems to environmental change in the Arctic and boreal region of western North America

Applications
Health & Air Quality
Ecological Forecasting
Water Resources
Disaster Applications & Response Team
Wildfires (through FY17)

Capacity Building
SERVIR (joint with USAID)
ARSET, Applied Remote Sensing Training
DEVELOP

Satellite Mission Planning
Early Adopters, Apps. Workshops

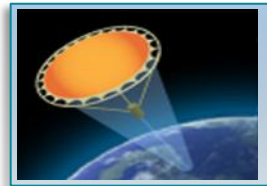
Program-wide
Socioeconomic Impact Analyses
Community Utilities (ESIP, NEX, etc.)
Communications
GEO and USGEO Support

President's FY17 Budget Request

- **Re-establishes funds for full SERVIR Applied Sciences Team FY16-18; expands Team in FY19-21 for increase to 6 SERVIR hubs by 2018**
- **Increases funding for Applications Areas (via internal re-allocation)**
- **Implements Snow & Water Availability focused activity for Western States**
- **Implements Food Security Consortium**
- **Implements Disaster Response Plan for increased preparation-based approach**
- **Continues activities to develop techniques to quantify social and economic benefits from Earth science applications**

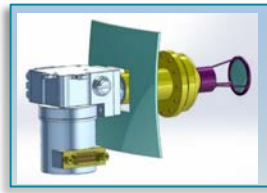
Earth Science Technology Office

Observation



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

Advanced Component Technologies (ACT)
critical components and subsystems for instruments and platforms
11 new projects added in FY14 (total funding ~$13M over 3 years)



Sustainable Land Imaging-Technology (SLI-T); *Managed by ESTO, funded from SLI*
new technologies and reduced costs for future land imaging (Landsat) measurements
First solicitation released in FY16 (total funding ~$29M over 5 years from SLI budget – investigations managed by ESTO)

Information

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
24 new projects added in FY15 (total funding ~$25M over 2 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
4 new projects added in FY15 (total funding ~$21M over 3 years)