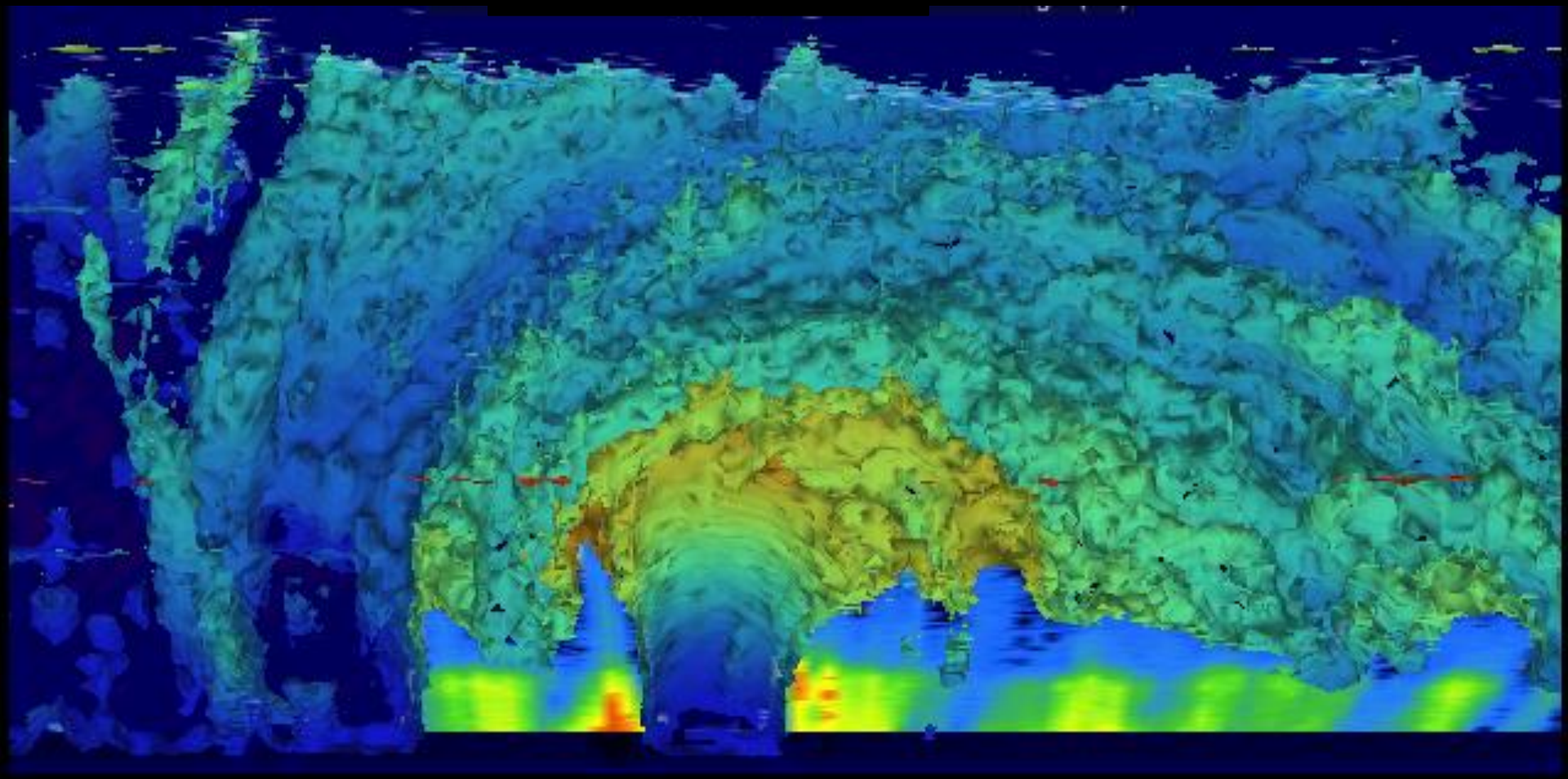
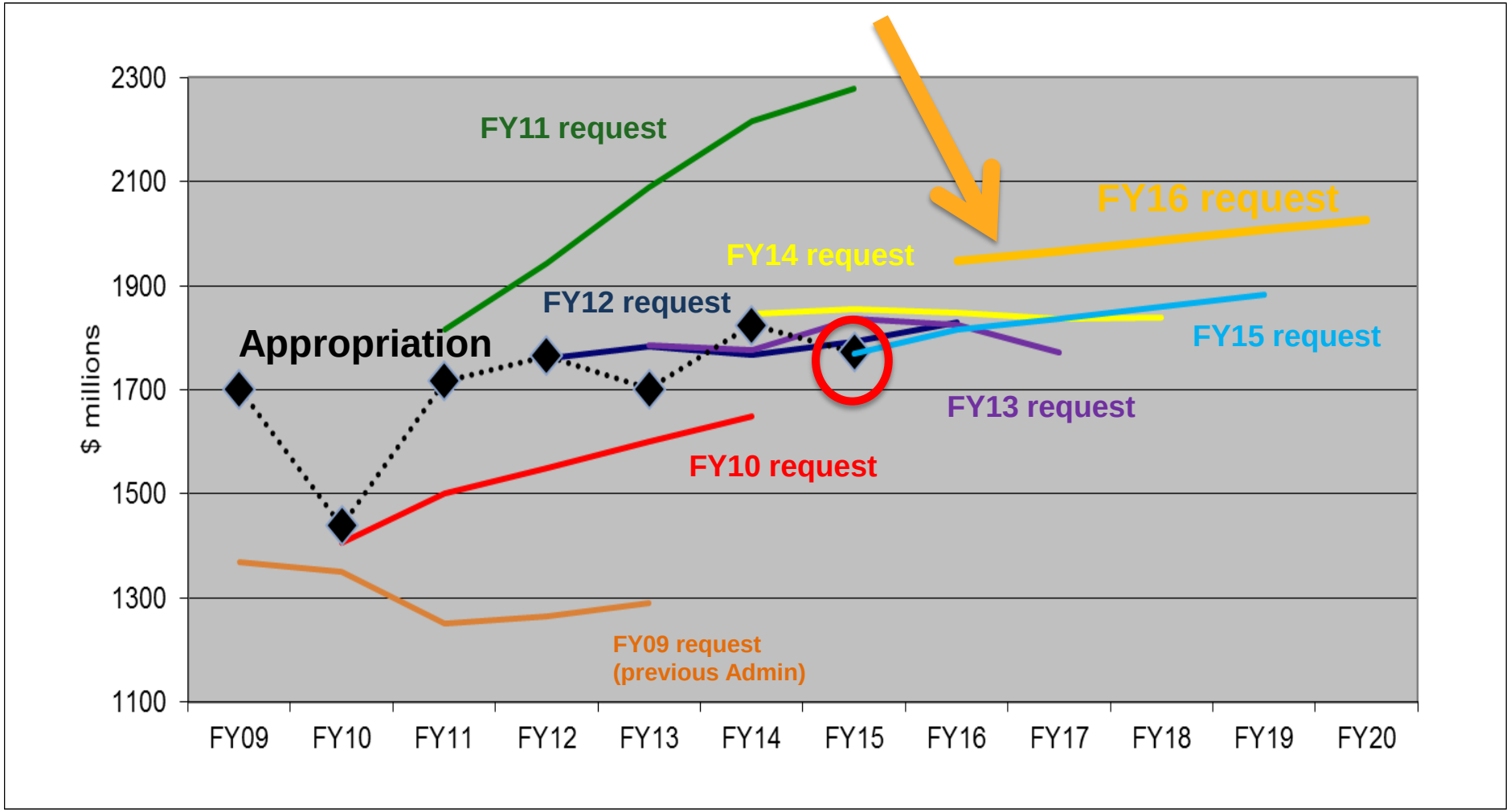
National Aeronautics and Space Administration



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

31 March 2015

Earth Science Budget:
FY16 Request/FY15 Appropriation



OVERALL SUMMARY (1 of 3)

- ESD budget increases significantly

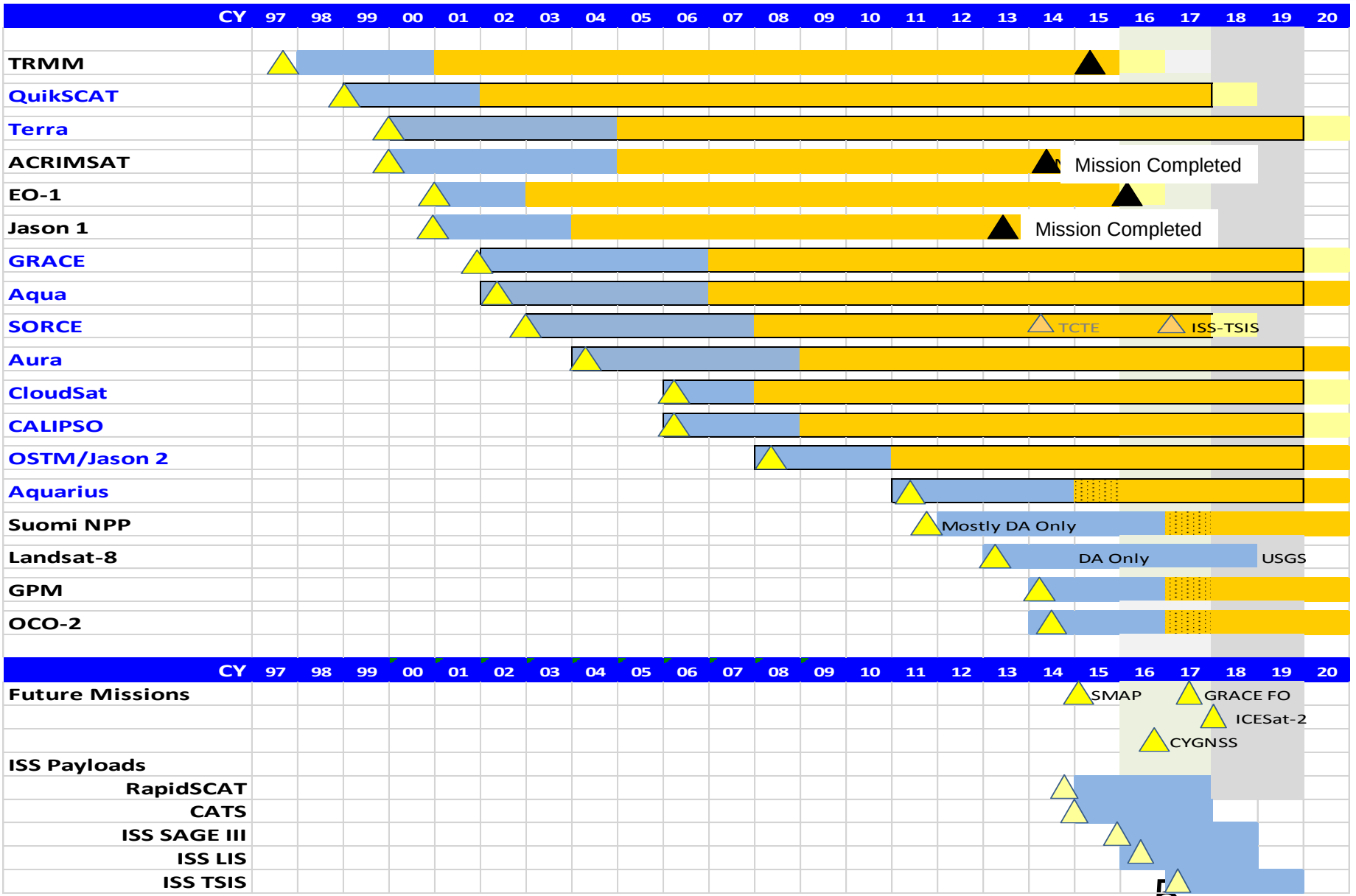
	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**1.730**	**1.894**	**1.913**	**1.932**	**1.952**	**1.971**
FY15		1.762	1.784	1.805	1.829	---

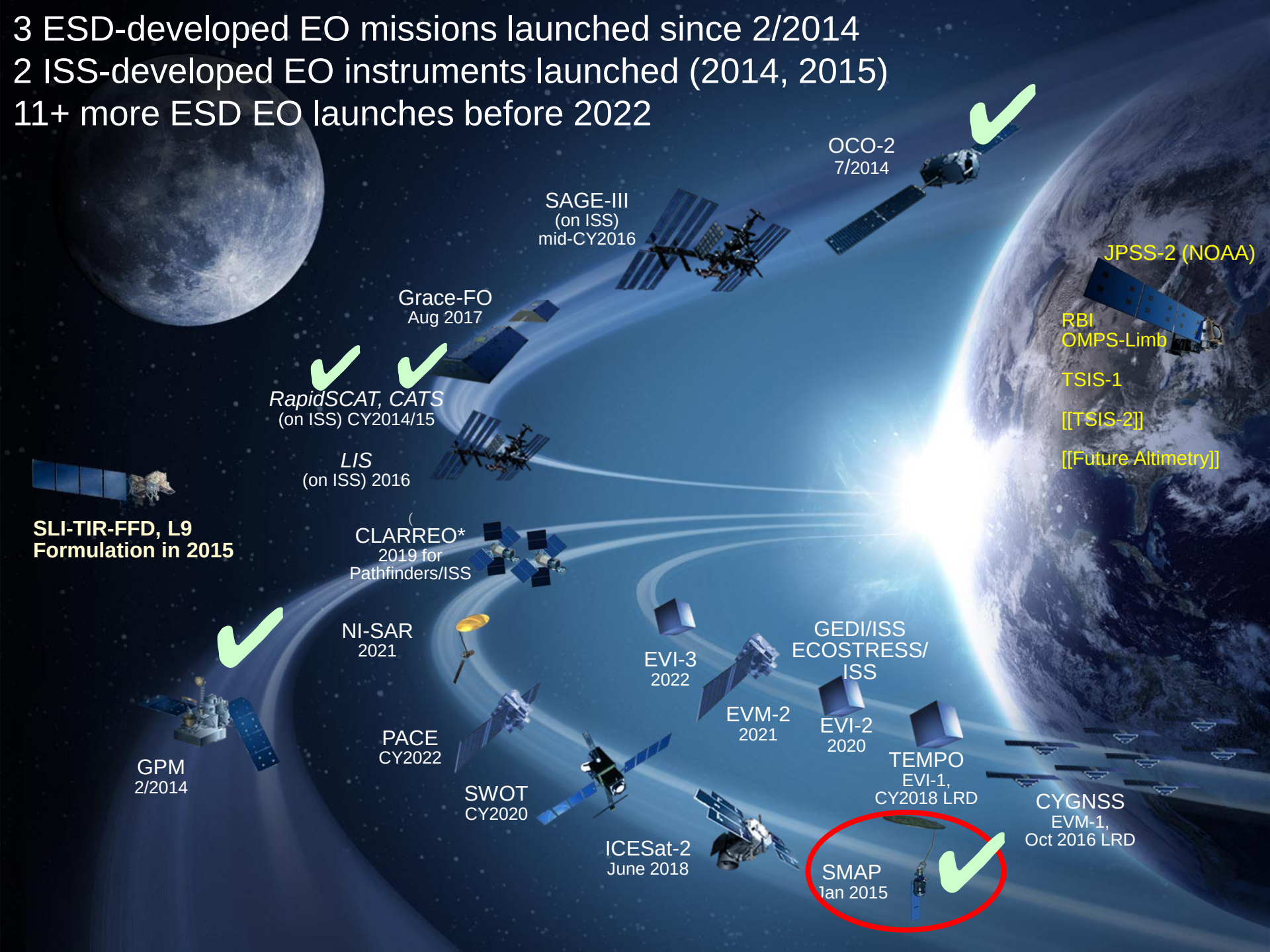
- NASA now has mandate for additional long-term measurements for the nation:
  - Altimetry after Jason-3
  - Solar Irradiance, Ozone Profile, Earth Radiation Budget all starting in FY16
- Sustainable Land Imaging Program (w/USGS; NASA funds flight hardware):
  - TIR-FFD (2019)
  - Upgraded Landsat-9 (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

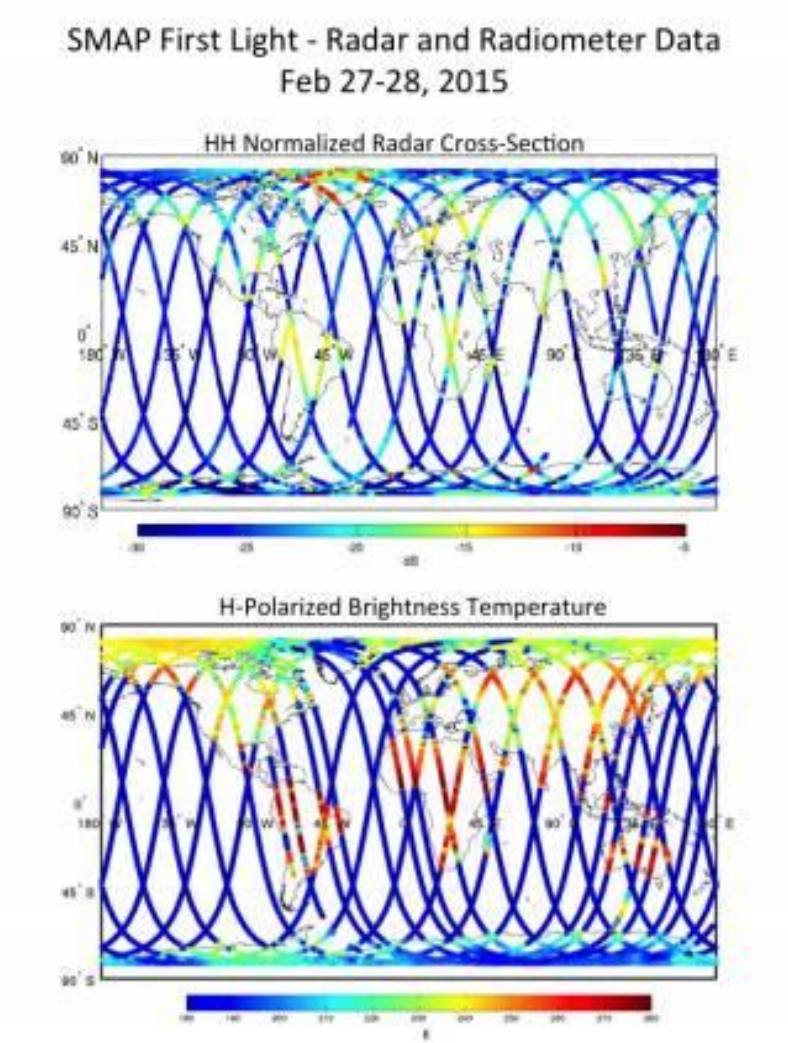
ED 2015 Senior Review Mission Set

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

SMAP First Light Image



First image from a test of the radar instrument on NASA's Soil Moisture Active Passive (SMAP) satellite Feb. 27-28. The test was performed with SMAP's antenna in a non-spinning mode, which limits measurement swath widths to 40 kilometers (25 miles).

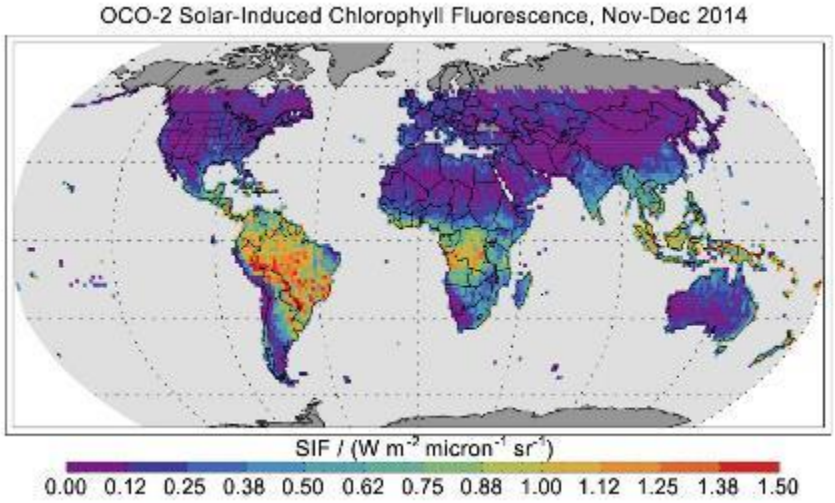
Image: NASA/JPL-Caltech/Goddard Space Flight Center

http://newsoffice.mit.edu/2015/first-light-images-nasa-smap-revealed-0310

OCO-2 Level 2 Product Status

- OCO-2 Level 2 products (global column CO_2 (XCO2)) are on track for release through GSFC DAAC by the end of March.
- The March 30th release will also include 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 will arrive at the DAAC on March 30th, and backward processing at ~3x will begin 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.



GPM Observes Super Typhoon Hagupit on Dec. 5th

December 4th, 5th:

Super Typhoon Hagupit threatens the Philippines a year after deadly Super Typhoon Haiyan devastated the island nation. GPM's Microwave Imager (GMI) observed extreme rates of almost 100.9 mm (almost 4 inches) per hour on the southern side of Hagupit's eye.

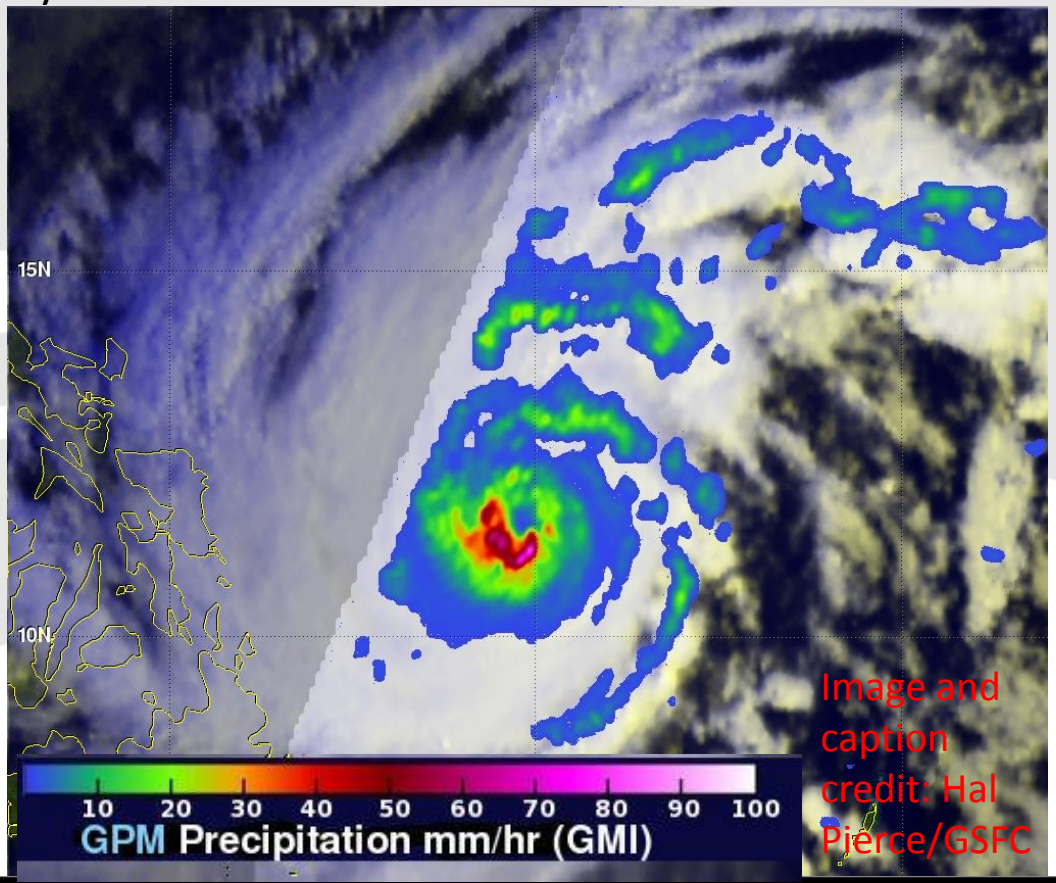
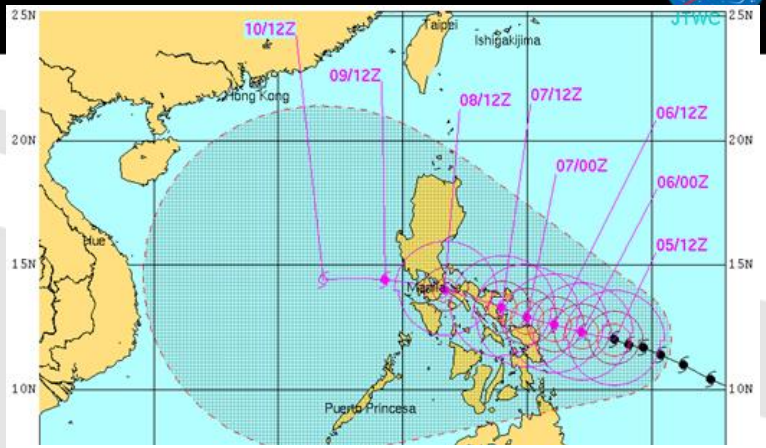
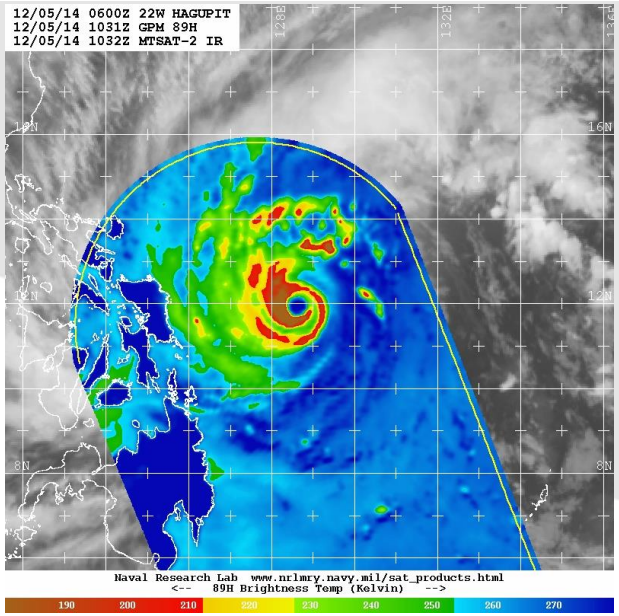


Image and caption credit: Hal Pierce/GSFC

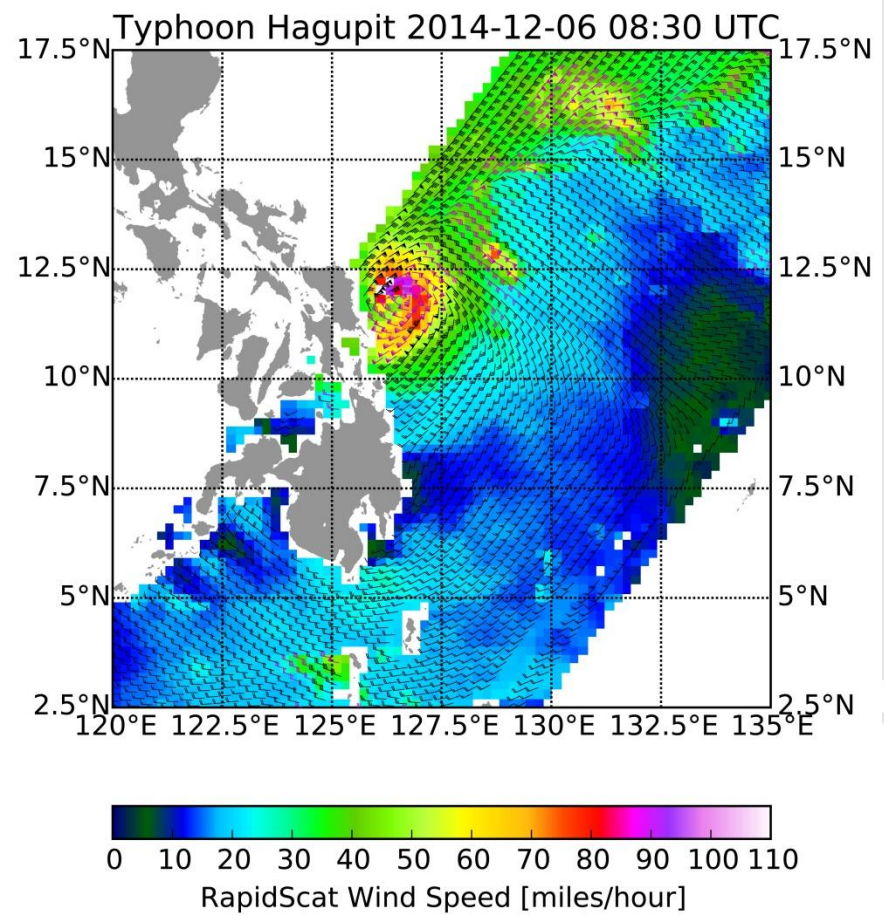


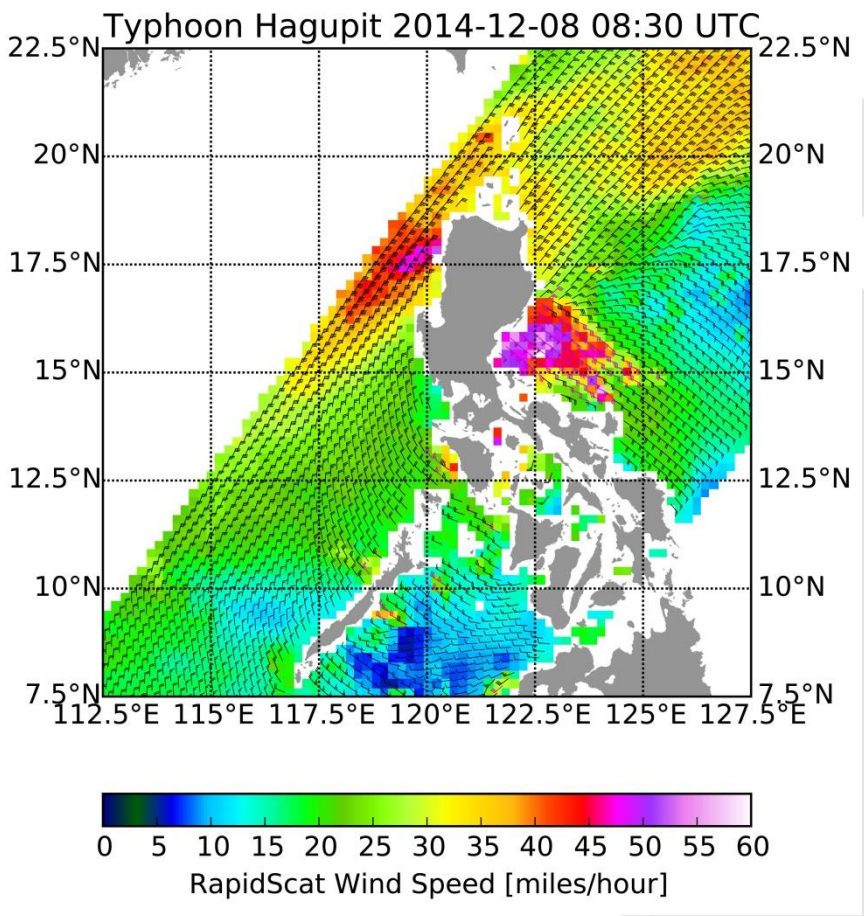
The Naval Research Lab (NRL) is using GMI and other sensors in their Automated Tropical Cyclone Forecasting System (ATCF) for improved track prediction.



http://www.nrlmry.navy.mil/tc_pages/tc_home.html

RapidScat Measurements of Hagupit



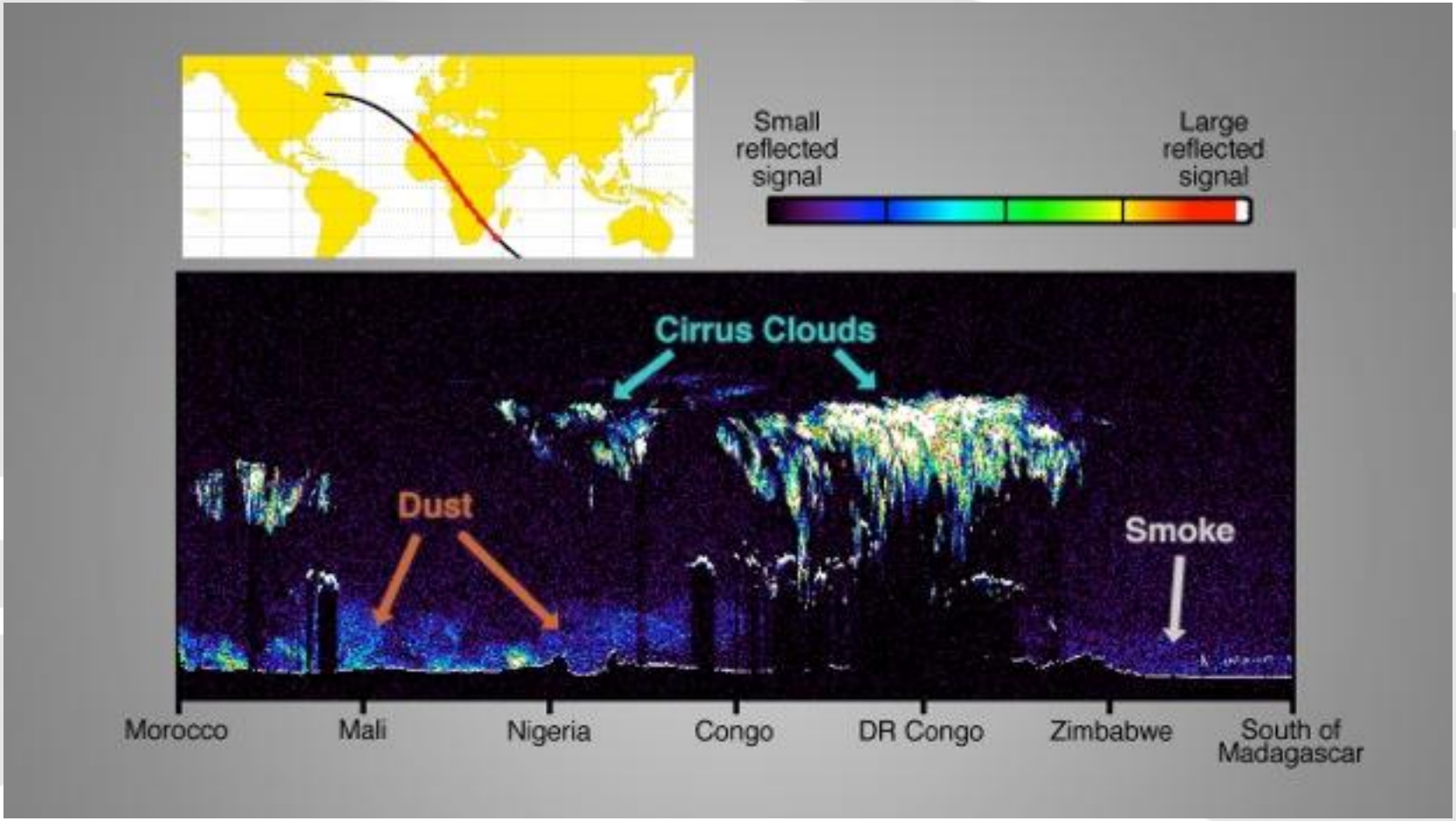


Note speed scale difference

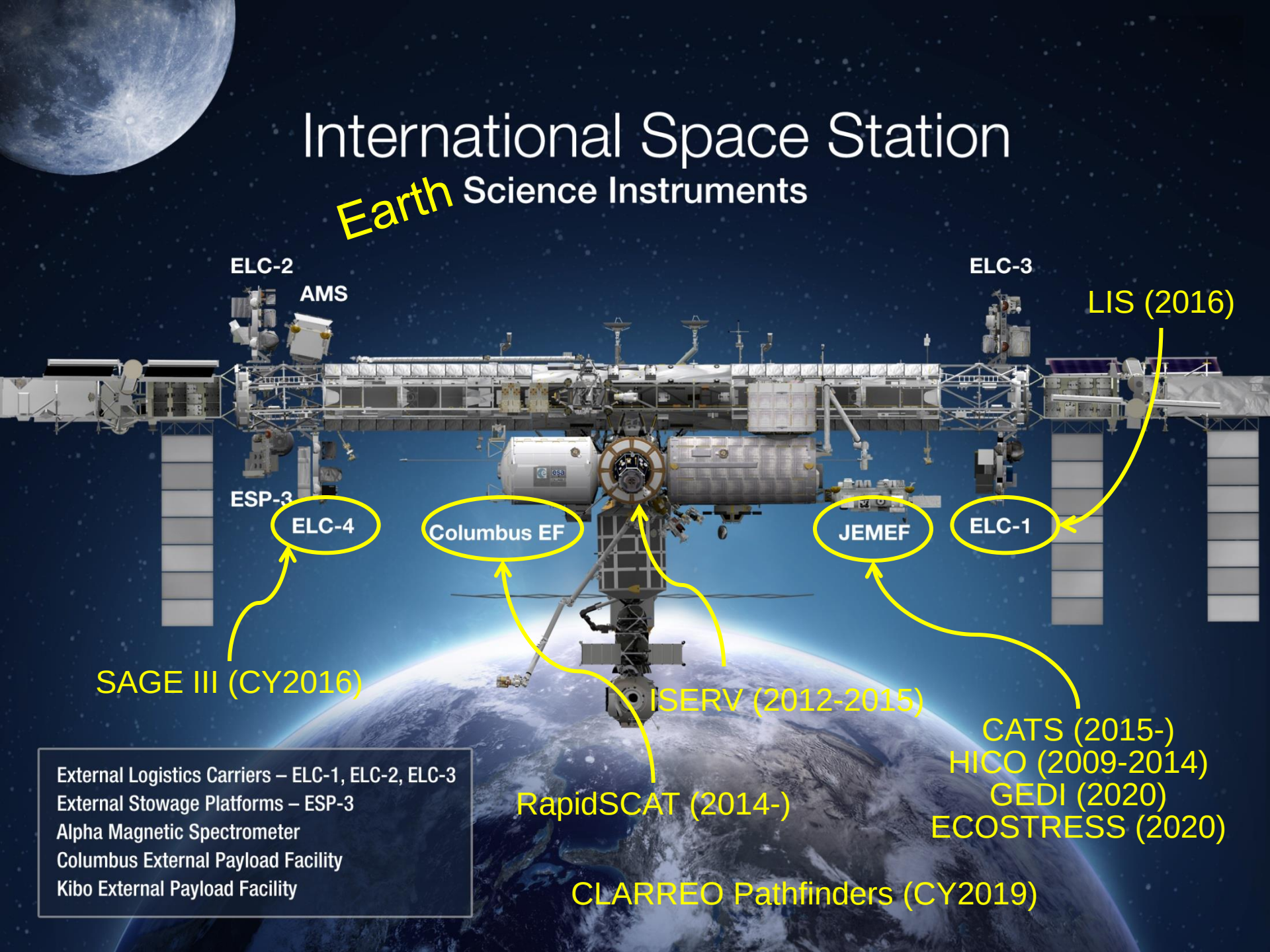
Image Credit: NASA/JPL-Caltech/NOAA

10

Early CATS Image

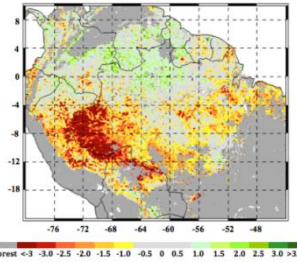


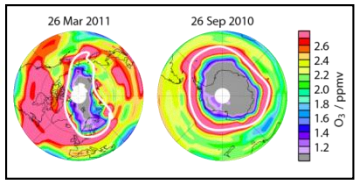
The CATS image shows a profile of particles in the atmosphere over a swath of Africa, from 30 degrees North to 30 degrees South, as the space station flew over it in the early morning of Feb. 11.

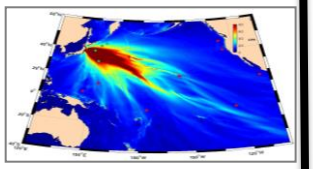

International Space Station
Earth Science Instruments
ELC-2
AMS
ELC-3
LIS (2016)
ESP-3
ELC-4
Columbus EF
JEMEF
ELC-1
SAGE III (CY2016)
ISERV (2012-2015)
CATS (2015-)
HICO (2009-2014)
GEDI (2020)
ECOSTRESS (2020)
RapidSCAT (2014-)
CLARREO Pathfinders (CY2019)
External Logistics Carriers – ELC-1, ELC-2, ELC-3
External Stowage Platforms – ESP-3
Alpha Magnetic Spectrometer
Columbus External Payload Facility
Kibo External Payload Facility

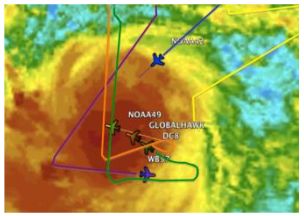
NASA's Earth Science Division

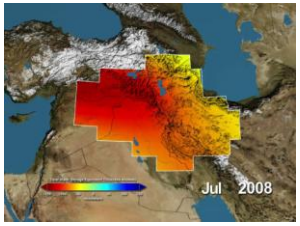
Research

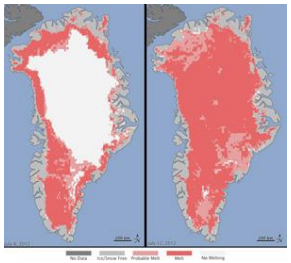




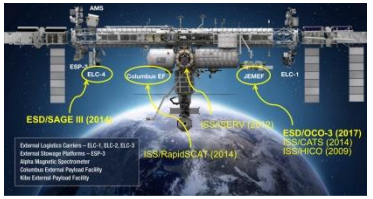




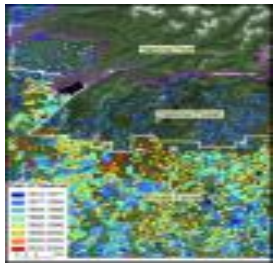


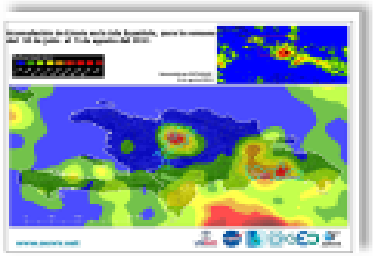


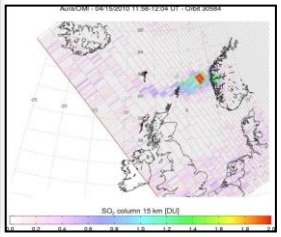
Flight

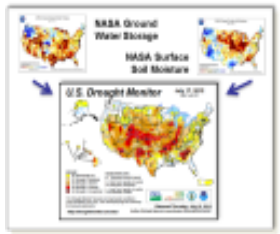


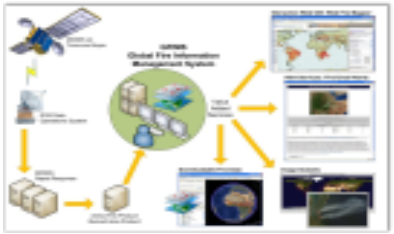
Applied Sciences

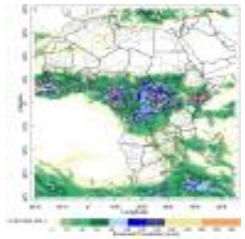




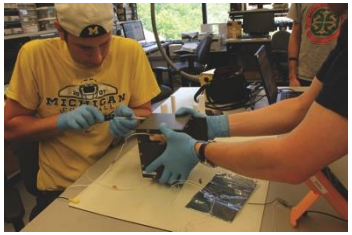


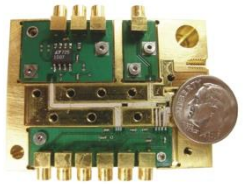






Technology





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

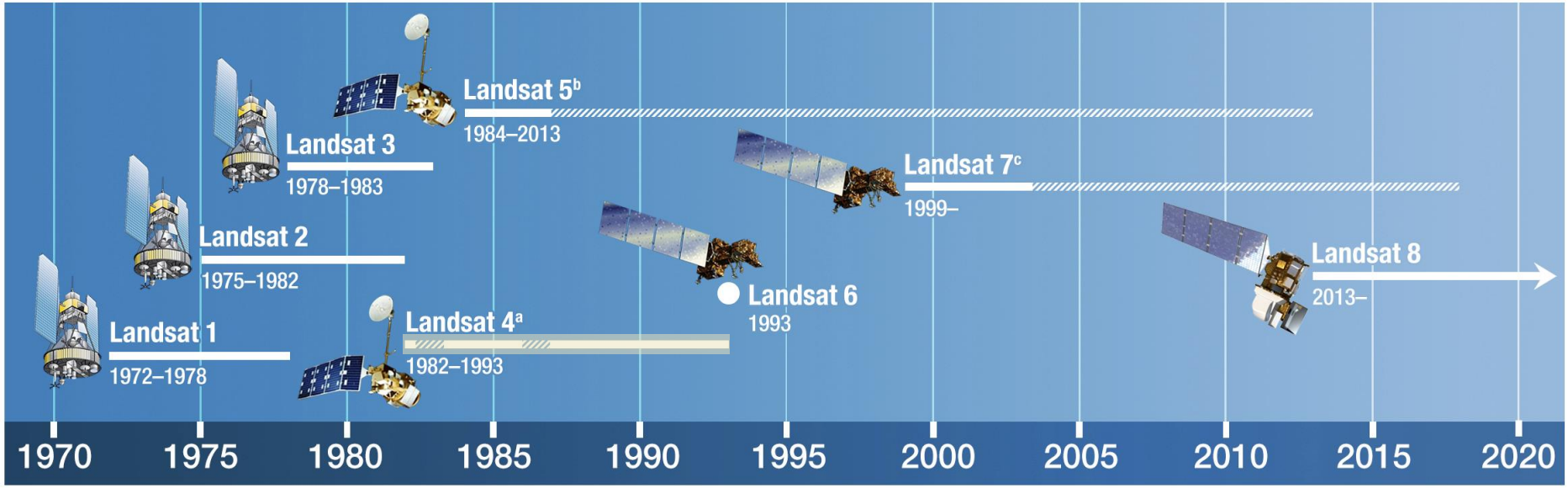
	FY15	FY16	FY17	FY18	FY19	FY20
FY16	**59.7**	**60.7**	**62.1**	**61.5**	**61.2**	**62.7**
FY15		54.5	55.6	55.5	55.6	---

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

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

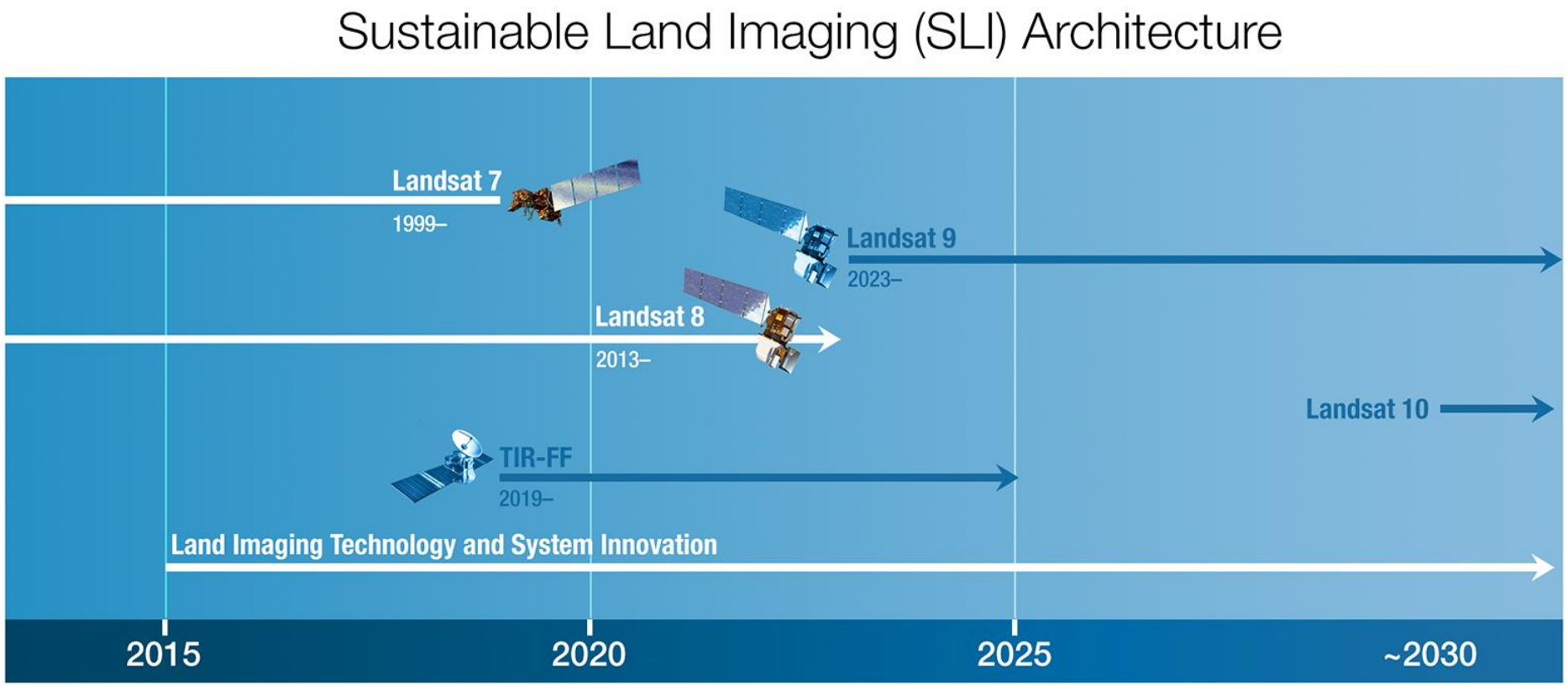
2. Landsat 9 (Class B upgraded rebuild of Landsat 8) to launch in 2023
   - Low programmatic risk implementation of a proven system with upgrades to bring the whole system to Class B

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)

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)

Venture Class Solicitation Schedule

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

Open solicitation

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

ROSES 2015 ESD Elements

A.2 Land Cover Land Use Change	12/1/15 (step 1)
A.8 Physical Oceanography	6/30/15
A.10 Surface Water and Ocean Topography Sci. Team	5/15/15
A.13 Modeling, Analysis, and Prediction	5/14/15
A.14 Cryospheric Science	6/16/15
A.15 IceBridge Observations	5/18/15
A.19 KORUS-AQ: An International Cooperative Air Quality Field Study in Korea	5/15/15
A.22 Science Utilizaiton of the Soil Moisture Active-Passive Mission	5/19/15
A.23 Precipitation Measurement Missions Science Team	6/30/15
A.26 Rapid Response and Novel Research in Earth Sci.	Rolling
A.27 GRACE and GRAE-FO Science Team	6/19/15
A.33 CloudSat and CALIPSO Science Team Recompete	7/31/15
A.34 Satellite Calibration Interconsistency Study	9/8/15
A.35 New (Early Career) Investigator Program in Earth Sci.	8/31/15
A.36 Adv Collaborative Connections for EarthSystem Sci.	724/15
A.42 In-Space Validation of Earth Science Technologies	5/29/15
A.43 NASA ISRO Snthetic Aperture Radar Mission SDT	6/8/15

Plus 4 TBD elements (will determine later)

ROSES12 Funded 14 Climate Indicators Projects

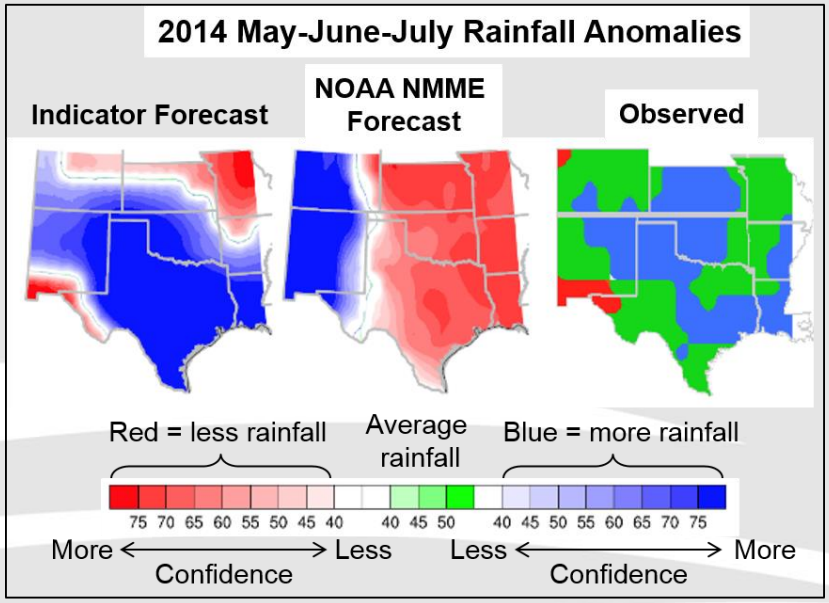
Project	PI
Land Cover Indicators for U.S. National Climate Assessments	*William Emanuel* PNNL
The **Agricultural Productivity** Indicator Analysis System (APIAS): Tracking the Agricultural Impacts of Climate Variability and Change	*Alex Ruane* GSFC/GISS
The **Timing of Arctic Sea Ice** Advance and Retreat as an Indicator of Ice-Dependent Marine Mammal Habitat	*Harry Stern* UW-Seattle
Cryosphere Radiative Forcing: An Indicator of Climate Feedback and Environmental Change	*Mark Flanner* U. of Michigan
Development and Testing of a **Dust** Indicator for Climate Assessment in the Western United States	*Daniel Tong* George Mason
Indicators Derived From TRMM/LIS Satellite **Lightning** Observations	*William Koshak* MSFC
Frequency of **Winter Weather**	*Jianhua Qian*

Project	PI
Translating EOS Datasets Into **National Ecosystem Biophysical Indicators**	*Steve Running* U. of Montana
Using NASA Earth Science Datasets for National Climate Assessment Indicators: Urban Impacts of **Heat Waves** Associated with Climate Change	*Stephanie Weber,* Batelle Memorial Institute
Water Cycle Intensification Indicator (WCI)	*Paul Houser* George Mason
Inland Water Temperature: An Ideal Indicator for the National Climate Assessment	*Simon Hook* JPL
Development of a **Water Clarity** Index for the Southeastern U.S. as a Climate Indicator	*Scott Sheridan* Kent State
Development of Integrated **Land Surface Water State** Indicators for Climate Assessment	*Kyle McDonald* City College of New York
Improving Assessment of Regional Climate Change in Supporting of Regional Resilience to **Extreme**	*Rong Fu* UT-Austin

New indicators of climate change leveraging NASA remote sensing resources

Early Warning of Summer Drought over Texas and the South Central U.S.

PI: Rong Fu, University of Texas - Austin

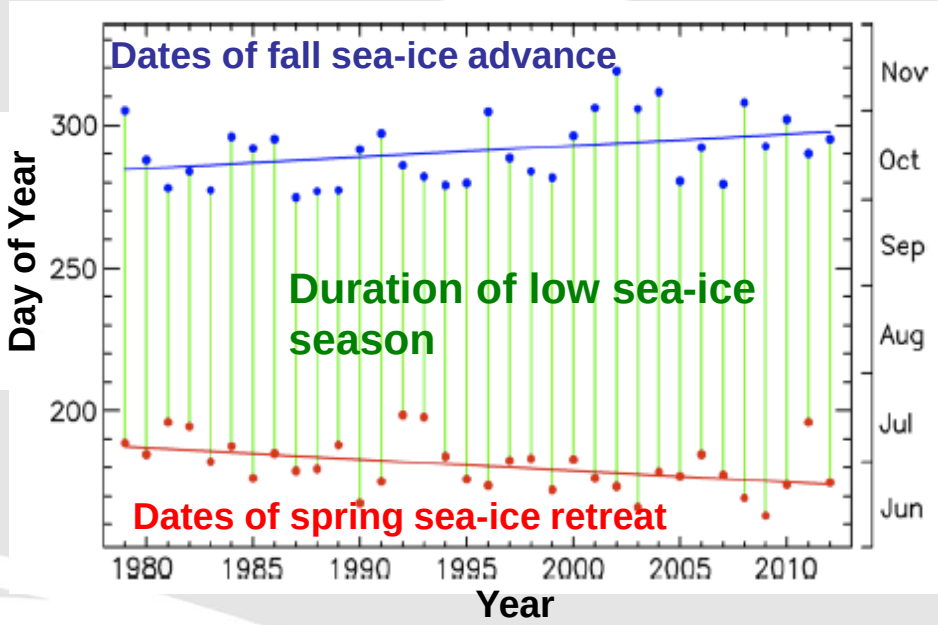


Statistical indicator for summer rainfall and drought prediction

- 70% effectiveness
- Outperforms existing models
- Utilizes data from MERRA
- Published report with the Texas Water Development Board

Timing of Arctic Sea Ice Advance and Retreat as an Indicator of Ice-Dependent Marine Mammal Habitat

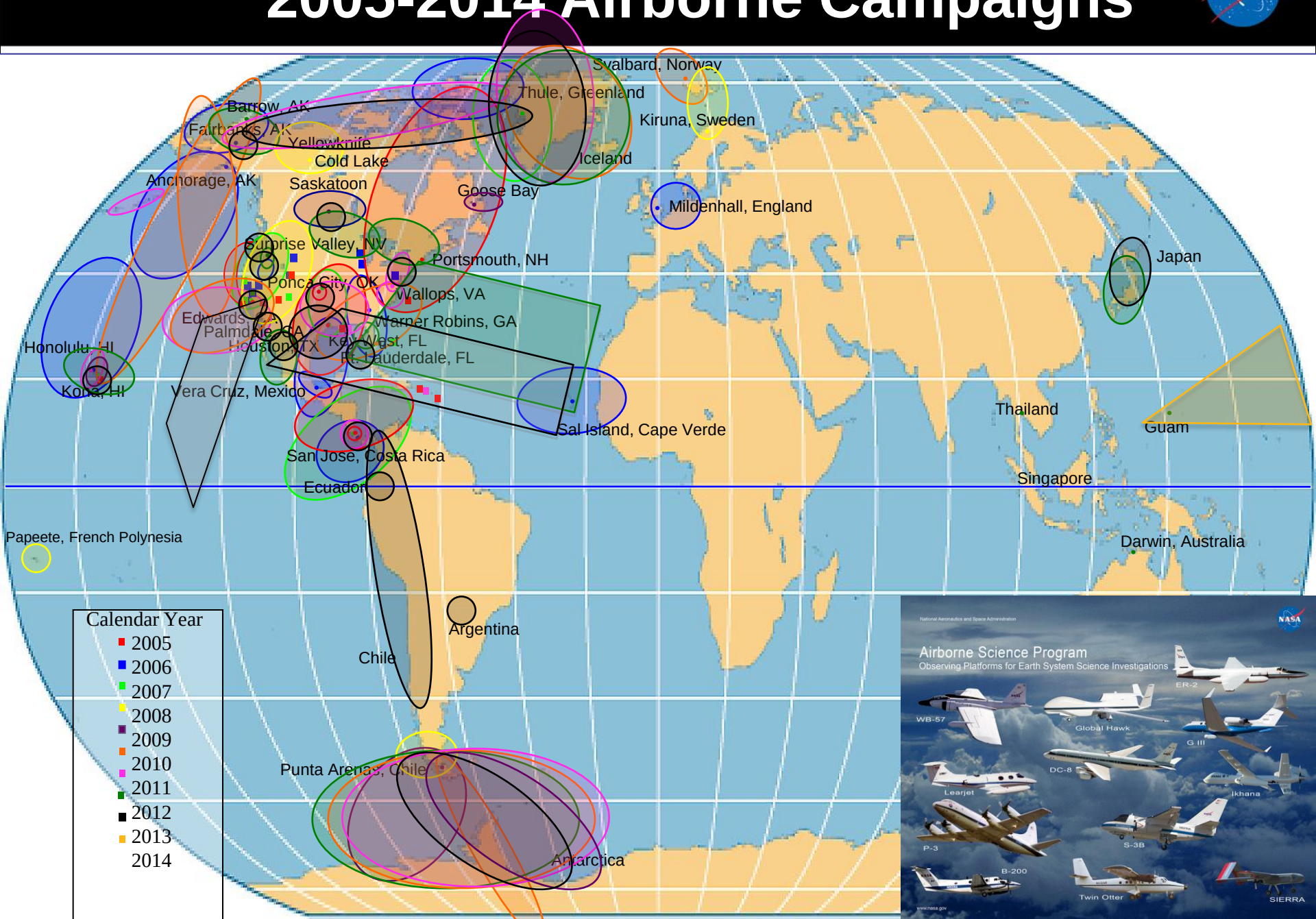
PI: Harry Stern, University of Washington, Seattle



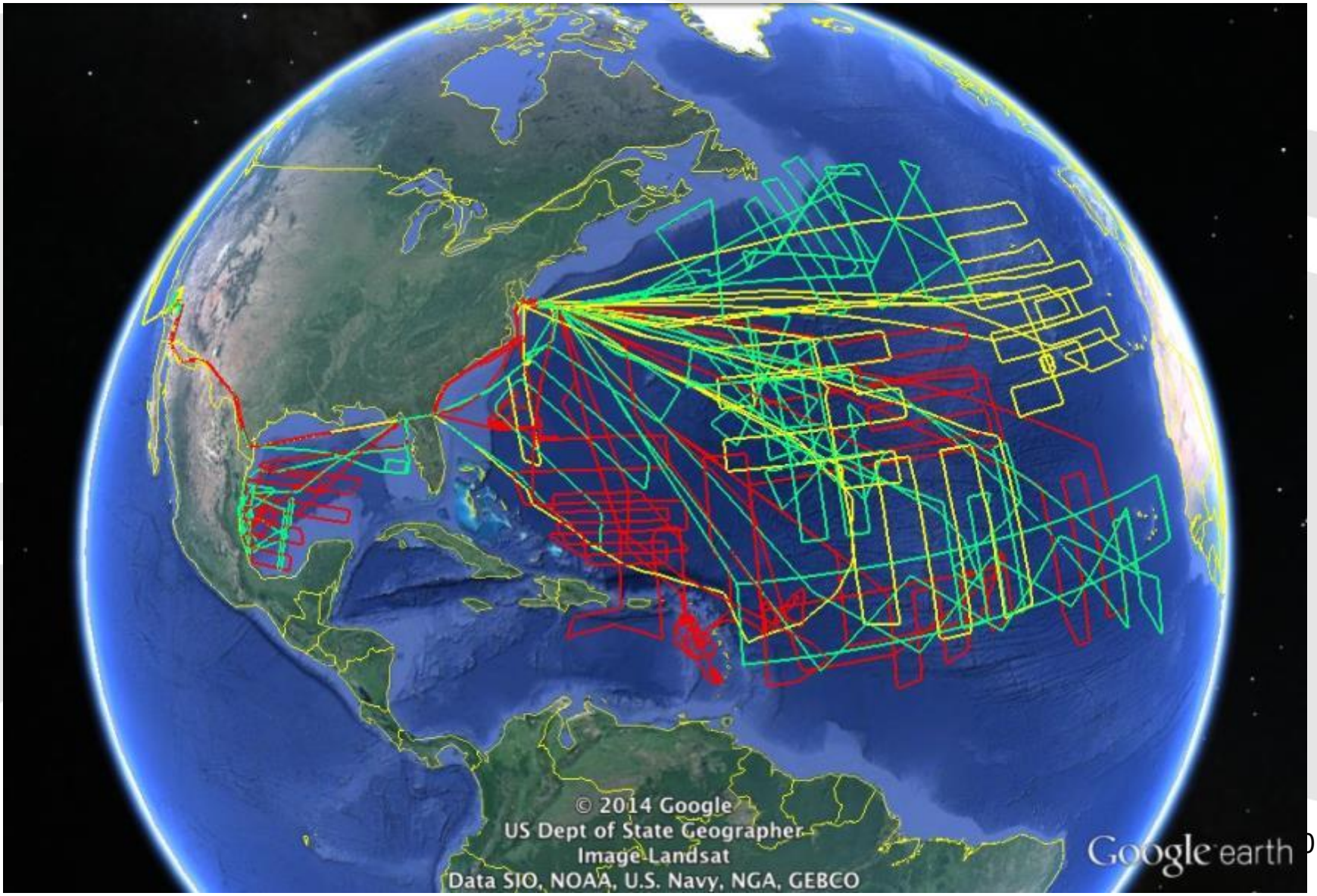
Habitat change indicator for ice dependent marine mammals

- Utilizes data from NSIDC
- Polar bear results are being used by Canada, Nunavut, Greenland, and the International Union for Conservation of Nature Red List and Polar Bear Specialist Group

2005-2014 Airborne Campaigns



HS3 2012 - 2014



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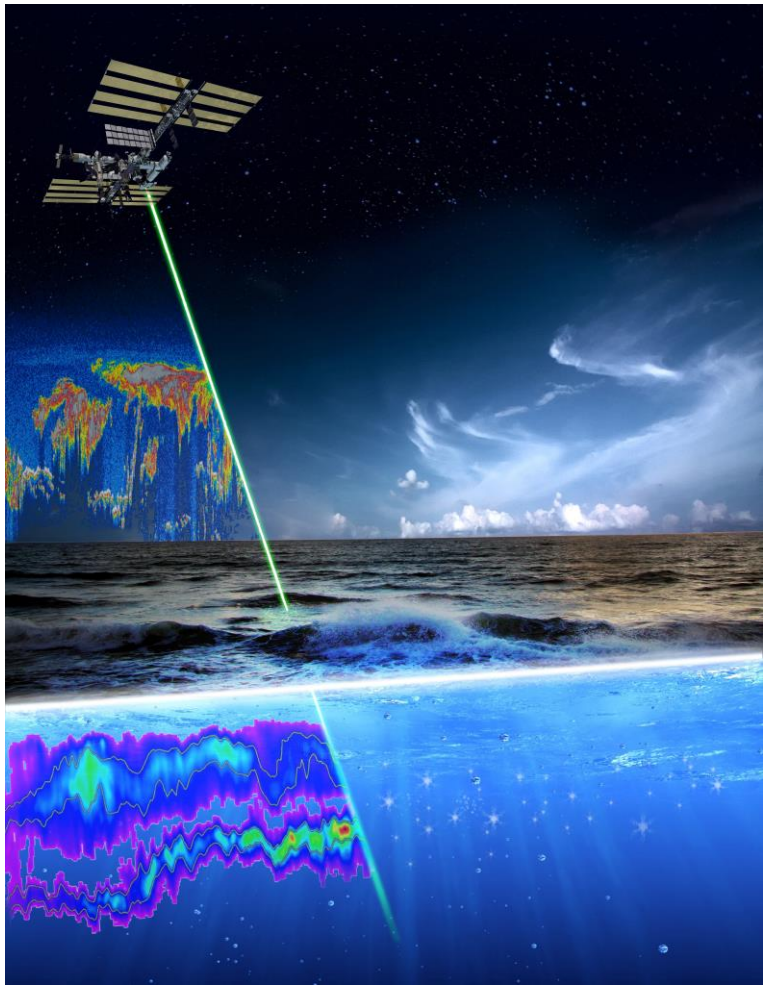
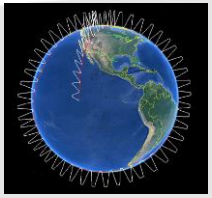
NASA Field Campaign to Probe Ocean Ecology, Carbon Cycle



www.nasa.gov/earthrightnow

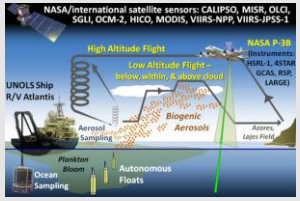
#AskNASA

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.

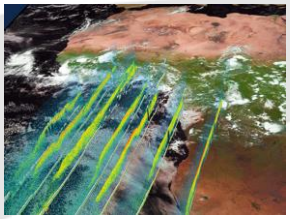


North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) – Oregon State U. (Mike Behrenfeld)

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.

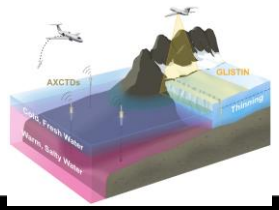
Atmospheric Carbon and Transport – America – Penn State University (Kenneth Davis)

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.



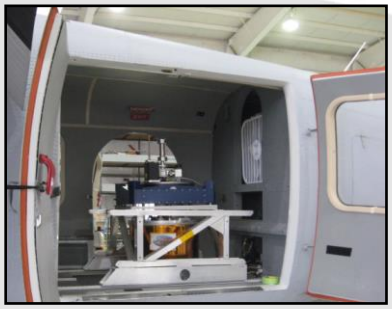
Oceans Melting Greenland (OMG) – JPL (Josh Willis)

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.

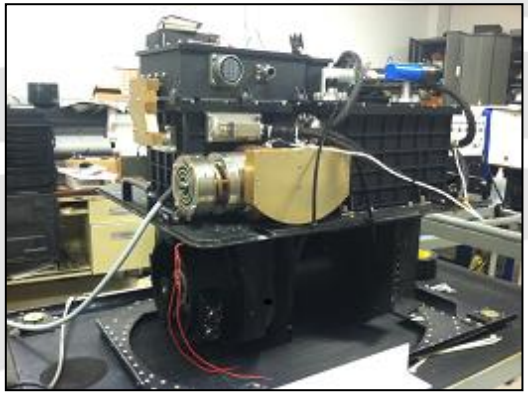

EVS-2 Mission Locations
ACT-America
ATom
NAAMES
OMG
ORACLES

Examples of New Airborne Sensors or those in Continuing Development

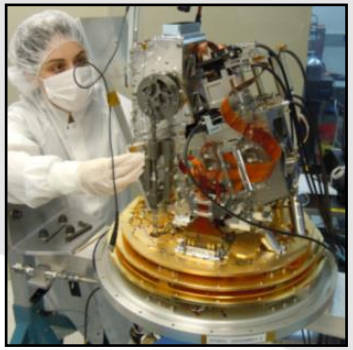
- HyTES is a hyperspectral, airborne imaging spectrometer with 256 spectral channels between 7.5 and 12 µm. It currently flies on Twin Otter aircraft but is being adapted to fly on the ER-2



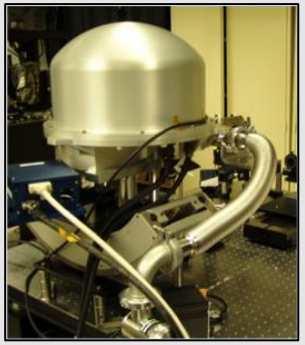
LVIS is a lidar designed to study surface features (canopy height, crevasse depth) that is being "facilitized" for future broad use



eMAS consists of two bore-sighted imaging spectro-radiometers: eMAS-Scanner: 38 bands (6.7µm – 14.0µm; 3.7µm; 445 – 2400nm) and eMAS-HS Imager: 205 bands 400 – 2450nm $\Delta\lambda$ 10nm; they simulate satellite observations, validate radiances,
And prototype future imager requirements



AVIRIS-ng extends capaiblities of AVIRIS-c with higher spectral resolution and SNR



PRISM covers the spectral range from 350 to 1050 nm at 2.85 nm resolution, with two longer wavelneth channels

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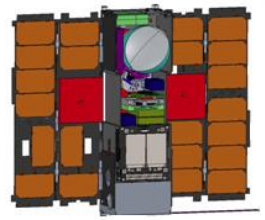
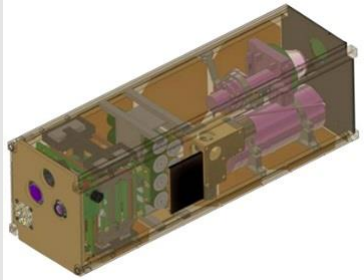
The need to space-validate new technologies is critical to reduce risk for future Earth science measurements. The In-Space Validation of Earth Science Technologies (InVEST) program is intended to fill the gap. The first InVEST solicitation in 2012 sought small instruments and subsystems that advance technology to enable relevant measurements and targeted the CubeSat platform.

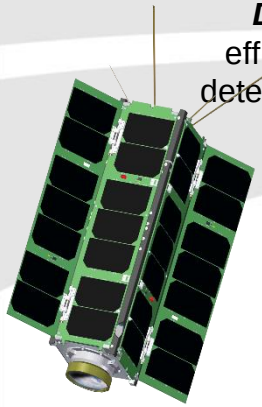


The ***Microwave Radiometer Technology Acceleration (MiRaTA) CubeSat*** will validate multiple subsystem technologies and demonstrate new miniature microwave radiometers operating near 52-58, 175-191, and 206-208 GHz that could dramatically enhance the capabilities of future temperature and humidity measurements. - K. Cahoy, MIT; **Launch NET 2016**

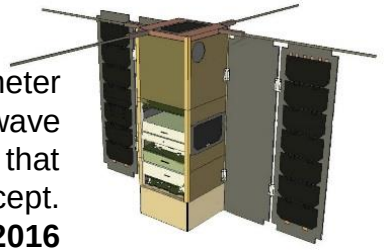
The ***Radiometer Assessment Using Vertically Aligned Nanotubes (RAVAN)*** project will demonstrate a bolometer radiometer that is compact, low cost, and absolutely accurate to NIST traceable standards. RAVAN could lead to affordable CubeSat constellations that, in sufficient numbers, might measure Earth's radiative diurnal cycle and absolute energy imbalance to climate accuracies (globally at 0.3 W/m2) for the first time. - W. Swartz, JHU/APL; **Launch NET 2016**



The objective of the ***CubeSat Flight Demonstration of a Photon Counting Infrared Detector (LMPC CubeSat)*** is to demonstrate in space, a new detector with high quantum efficiency and single photon level response at several important remote sensing wavelength detection bands from 1 to 2 microns. - R. Fields, Aerospace Corporation; **Launch NET 2016**



The ***HyperAngular Rainbow Polarimeter HARP-CubeSat*** will validate a technology required by the Aerosol-Cloud-Ecosystem (ACE) mission concept and prove the capabilities of a highly-accurate, wide-FOV, hyperangle, imaging polarimeter for characterizing aerosol and cloud properties.
- J. V. Martins, UMBC; **Launch NET 2016**



IceCube is a three unit (3U) CubeSat under development to validate a 874-GHz radiometer receiver for future use in ice cloud measurement missions. This submillimeter wave radiometer technology could directly benefit an ice cloud imaging radiometer such as that called for by the Aerosol-Cloud-Ecosystem (ACE) mission concept.
- D. Wu, NASA Goddard Space Flight Center; **Launch NET 2016**

InVEST-12 ($13M total; selections made 5/03/13); limited to 3U

All tasks are progressing on schedule. Launch opportunities are being identified for 2016.

Microwave Radiometer Technology Acceleration (MiRaTA)

- CDR scheduled for 4/13-14/15

Radiometer Assessment Using Vertically Aligned Nanotubes (RAVAN)

- Second year interim review held 2/23/15

Cubesat Flight Demonstration of a Photon Counting Infrared Detector (LMPC CubeSat)

- CDR scheduled for 5/08/15

HyperAngular Rainbow Polarimeter (HARP)

- Second year interim review held 2/24/15

IceCube

- CDR scheduled for4/28/15

InVEST-15 ($14.6M total) - *Solicitation is now open; up to 6U*

NOI's due: 3/27/15; Proposals due: 5/29/15

Selections expected late FY2015

Awards are for 3 years nominally. PI's develop to flight readiness. Launches are provided through the NASA CubeSat Launch Initiative (CSLI) program.

ESD-Related Personnel Receiving External Rdcognition

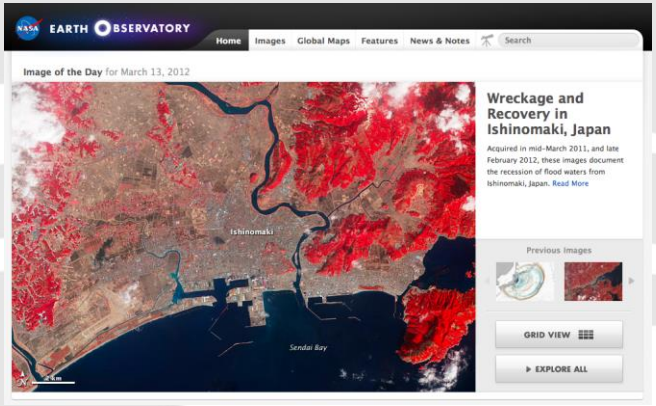
- The AMS Helmut E. Landsberg Award went to Jeffrey Luvall and Dale Quattrochi of MSFC. The citation reads "For original contributions and leadership in using high-resolution thermal remote sensing data to understand the urban heat island effect and its environmental consequences”
- The AMS Cleveland Abbe Award for Distinguished Service to Atmospheric Science was presented to former NASA scientist and executive Dixon M. Butler "For visionary, dedicated leadership in Earth observation, science education and federal management of science which has had lasting impact on the development of Earth System Science.”
- The AMS Board on Outreach and Pre-College Education (BOPE) named the NASA-led GLOBE program as a winner of the "2014 Distinguished Educator Recognition Program"– with Tony Murphy of UCAR the lead recipient.
- In February 2015, JPL Director for the Center for Climate Sciences *Graeme L. Stephens*, and NASA PI (and former IPA) *Eric F. Wood* were elected to the National Academy of Engineering, the highest professional distinction for engineers.
- Among the AGU Fellows in 2014 were Christian Frankenberg (JPL), Phil Russell (ARC), former GISS employee Drew Shindell (now Duke Univ.), former AA Ghassem Asrar (now PNNL/JGCRI), and numerous present and former principal investigators

Communications Tools for NASA's Global Environmental Data

Eyes on the Earth-3D Website*

Dynamic Planet

NASA Earth Now iPhone App



Earth Observatory Web Site

Climate.nasa.gov web site

NASA Hyperwall

*****Software demonstrated to audience at US Center at COP-18 meeting in Doha, Qatar

Your Planet is Changing

Earth Right Now

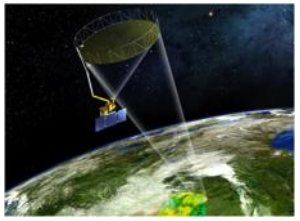
We're on it!

GPM

OCO-2

RapidScat

CATS



SMAP