National Aeronautics and
Space Administration

EXPLORE

Earth Science Technology Forum Thoughts and Conclusions

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ESTF2020

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ESTO

Flexible, Science-driven Strategy

Science-focused solicitations that encourage broad participation among academia, industry, federal labs, and NASA

Competitive, peer-review process to enable selection of best-of-class investments

Active approach to:

- **Project management** – cost / schedule / performance
- **Partnering** – leverage existing technologies and opportunities (including SBIR, external consortia, and other federal efforts)
- **Communications** – effective reporting to a variety of audiences and stakeholders

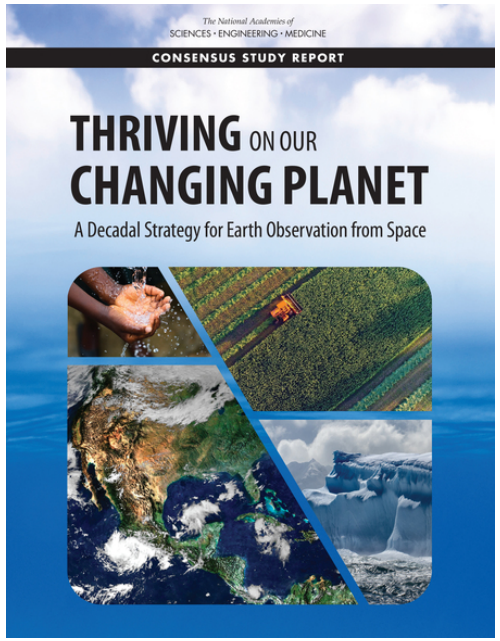
This strategy has resulted in:

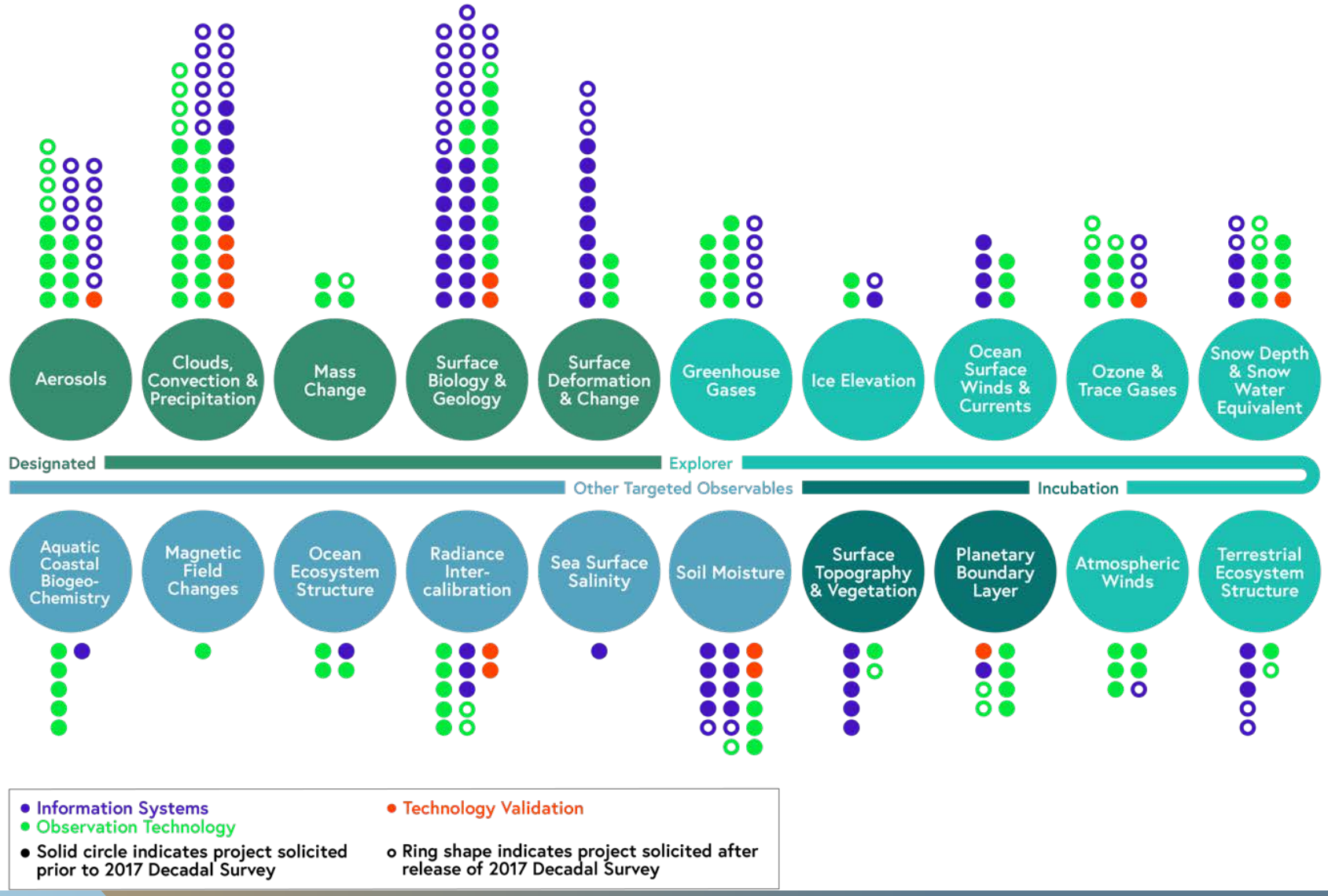
A portfolio of emerging technologies that will enhance and/or enable future Earth science measurements

An ever-growing cohort of infusion successes into science campaigns, instruments, applications, ground systems, and missions

ESTO Projects Supporting the 2017 Decadal Survey

Targeted Observables in lieu of missions provides flexibility for creative affordable observing systems





Earth Science Technology Program Elements

ESTO manages, on average, 120 active technology development projects. Most are funded through the primary program lines below. Over 830 projects have completed since 1998.

Advanced Technology Initiatives: ACT and InVEST

Advanced Component Technologies (ACT)
Critical components and subsystems for advanced instruments and observing systems

12 projects awarded in 2018
Solicitations planned in FY20, and FY22
- proposals due July 21, 2020

In-Space Validation of Earth Science Technologies (InVEST)
On-orbit technology validation and risk reduction for small instruments and instrument systems.

Four projects selected in FY18
Solicitations planned in FY21 and FY24

Instrument Incubator Program (IIP)

Earth remote sensing instrument development from concept through breadboard and demonstration

ICD – instrument concept demonstrations
IDD – instrument development and demonstrations

19 projects awarded in FY19
Solicitations planned in FY21 and FY23

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

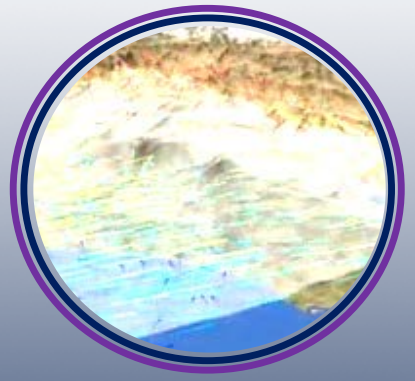
NOS – new observing strategies
ACF – analytic center framework

22 projects awarded in FY19
Solicitations planned in FY21 and FY23

New Program Decadal Incubation

Maturation of observing systems, instrument technology, and measurement concepts for **Planetary Boundary Layer and Surface Topography and Vegetation observables** through technology development, modeling, system design, analysis activities, and small-scale pilot demonstrations

Two study teams awarded in FY20
Solicitation planned in FY21



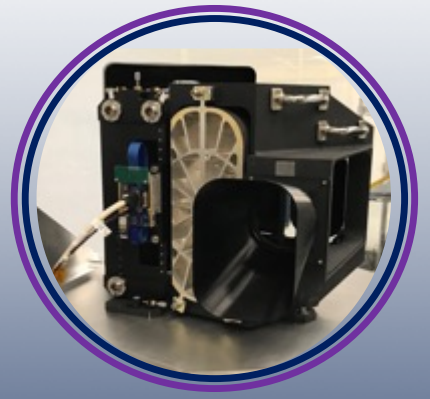
Other ESD Technology Activities Managed by ESTO

ESTO also manages specific sets of technology development and integration projects on behalf of the ESD Flight programs and research

Sustainable Land Imaging – Technology

Funded by the Flight Program, the **Sustainable Land Imaging-Technology (SLI-T)** program **d**evelops innovative technologies to achieve future land imaging (Landsat) measurements with more efficient instruments, sensors, components and methodologies.

First solicitation released in FY16
Solicitation planned in FY20
- proposals currently in review



Earth Venture Instruments – Technology

With funding from the Flight Program's Earth Systems Science Pathfinder (ESSP) program, the **Earth Venture Instruments – Technology (EVI-T)** program develops promising, highly-rated Earth Venture proposals that require additional technology risk reductions (average award: $5 - 8M)

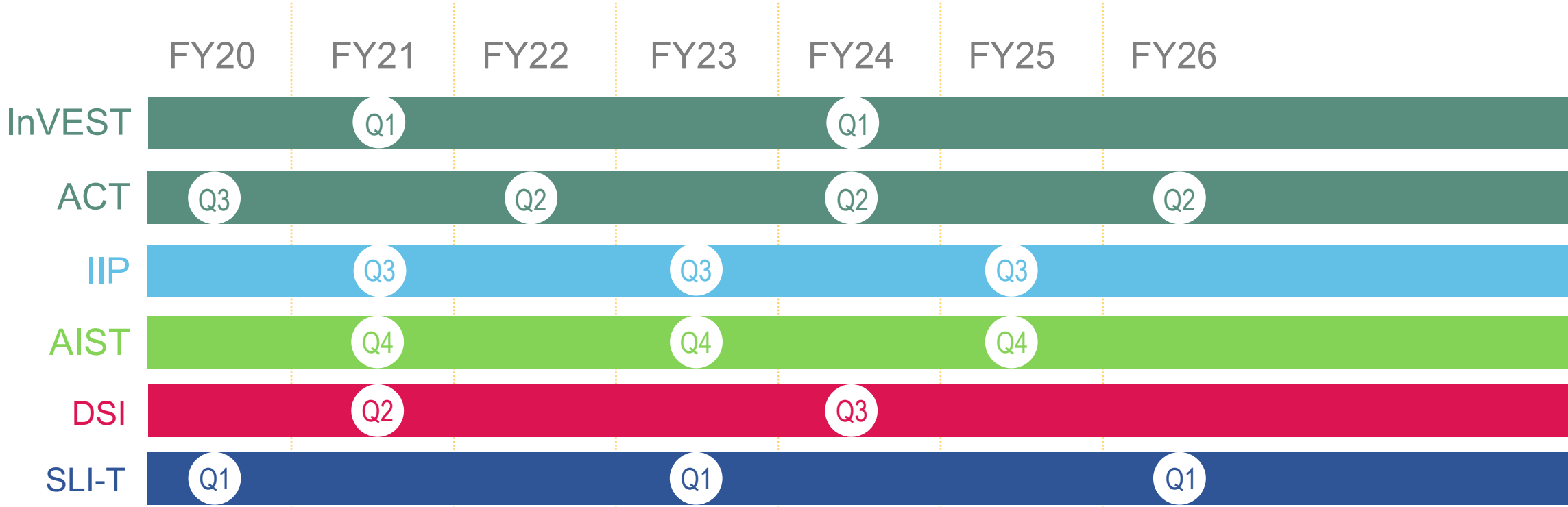
Airborne Instrument Technology Transition

The **Airborne Instrument Technology Transition (AITT)** program provides campaign ready airborne instrumentation to support the objectives of the R&A Program. AITT converts mature instruments into operational suborbital assets that can participate in field experiments, evaluate new satellite instrument concepts, and/or provide calibration and validation of satellite instruments.

Ocean Biology and Biogeochemistry

With funding through the R&A Program, the **Ocean Color Remote Sensing Vicarious Calibration Instruments** program develops in situ vicarious calibration instrument systems to maintain global climate-quality ocean color remote sensing of radiances and reflectances

Solicitation Calendar



COVID-19

As far as we know, as of today, NASA is not getting any additional funds

- ESTO Program Managers are working with all PI's to mitigate impacts
- We will support requests for No Cost Extensions
- On a case to case basis - we may be able provide augmentations, we may also suggest and support appropriate descope options
- Getting back to work – we appreciate that we can't work the same way, that we need to take into account safe working environments – work will likely take longer and cost more
- ESTO solicitations will keep current schedule – we want PI's to continue to INNOVATE
  - We may not be able to award as many proposals, TBD

NASA's Science 2020-2024 Strategy

A Vision for Scientific Excellence

https://science.nasa.gov/science-pink/s3fs-public/atoms/files/2020-2024_Science.pdf

PRIORITY 2
INNOVATION

STRATEGY 2.1: Foster a culture that encourages innovation and entrepreneurship across all elements of the SMD portfolio.

STRATEGY 2.2: Foster a culture that encourages collaboration in pursuit of common goals.

STRATEGY 2.3: Enhance our focus on high intellectual risk/high impact research investments.

STRATEGY 2.4: Drive innovation in focused technology areas to capitalize on the rapid evolution of commercial capabilities.

2.1 RainCube used as an example of risk reduction for future missions

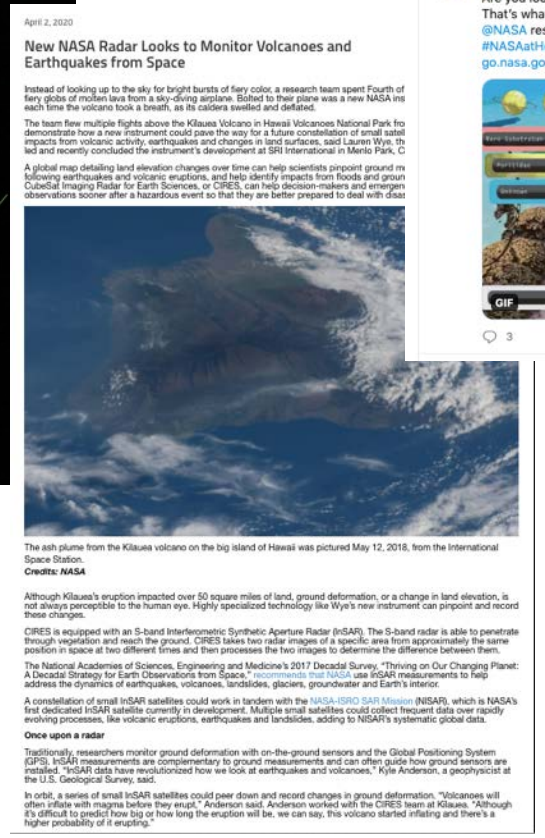
2.2 Best practices and technologies leveraged across divisions, ie, PESTO

2.3 High risk high impact proposals

2.4 Also some universities and other labs have unique capabilities

ESTO Communications

Objective: To foster collaborations among researchers, strengthen connections across NASA, share new Earth observing capabilities with scientists, promote successful project infusions, and spur interest in Earth science technologies from decision makers and the public.



April 2, 2020

New NASA Radar Looks to Monitor Volcanoes and Earthquakes from Space

Instead of looking up to the sky for bright bursts of fiery color, a research team spent Fourth of fiery globs of molten lava from a sky-diving airplane. Bolted to their plane was a new NASA ins each time the volcano took a breath, as its caldera swelled and deflated.

The team flew multiple flights above the Kilauea Volcano in Hawaii Volcanoes National Park fro demonstrate how a new instrument could pave the way for a future constellation of small satell impacts from volcanic activity, earthquakes and changes in land surfaces, said Lauren Wye, th led and recently concluded the instrument's development at SRI International in Menlo Park, C

A global map detailing land elevation changes over time can help scientists pinpoint ground m following earthquakes and volcanic eruptions, and help identify impacts from floods and groun CubeSat Imaging Radar for Earth Sciences, or CIRES, can help decision-makers and emergen observations sooner after a hazardous event so that they are better prepared to deal with disa

The ash plume from the Kilauea volcano on the big island of Hawaii was pictured May 12, 2018, from the International Space Station.
Credits: NASA

Although Kilauea's eruption impacted over 50 square miles of land, ground deformation, or a change in land elevation, is not always perceptible to the human eye. Highly specialized technology like Wye's new instrument can pinpoint and record these changes.

CIRES is equipped with an S-band Interferometric Synthetic Aperture Radar (InSAR). The S-band radar is able to penetrate through vegetation and reach the ground. CIRES takes two radar images of a specific area from approximately the same position in space at two different times and then processes the two images to determine the difference between them.

The National Academies of Sciences, Engineering and Medicine's 2017 Decadal Survey, "Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space," recommends that NASA use InSAR measurements to help address the dynamics of earthquakes, volcanoes, landslides, glaciers, groundwater and Earth's interior.

A constellation of small InSAR satellites could work in tandem with the NASA-ISRO SAR Mission (NISAR), which is NASA's first dedicated InSAR satellite currently in development. Multiple small satellites could collect frequent data over rapidly evolving processes, like volcanic eruptions, earthquakes and landslides, adding to NISAR's systematic global data.

Once upon a radar

Traditionally, researchers monitor ground deformation with on-the-ground sensors and the Global Positioning System (GPS). InSAR measurements are complementary to ground measurements and can often guide how ground sensors are installed. "InSAR data have revolutionized how we look at earthquakes and volcanoes," Kyle Anderson, a geophysicist at the U.S. Geological Survey, said.

In orbit, a series of small InSAR satellites could peer down and record changes in ground deformation. "Volcanoes will often inflate with magma before they erupt," Anderson said. Anderson worked with the CIRES team at Kilauea. "Although it's difficult to predict how big or how long the eruption will be, we can say, this volcano started inflating and there's a higher probability of it erupting."

Outreach Efforts:

- ESTF – Venue alternates East and West Coasts, or Virtual
- Press Releases, Articles, Social Media…
- Website – *new check it out* - https://esto.nasa.gov/
- Annual Reports – distributed at AGU
- Conference Exhibits – AGU, AMS, IGARSS…
- Brown Bag Talks at NASA HQ

TEMPEST-D and CubeRRT ISS Deployment

Observation Technologies - Strategy

Rapid Advances are enabling smaller integrated, intelligent and affordable instruments that use:

- Modularized system architectures (plug & play)
- Architectures that allow increased flexibility and adaptability
  - Active/passive measurement techniques (Radar/Radiometer, Lidar/Spectrometer)
- Mass producible miniaturized key instrument components and subsystems
- Rapidly emerging technologies
  - Photonic Integrated Circuits
  - System on a chip solutions
  - Free form optics
  - Room temperature detectors
  - Other compact electronic and optical architectures
  - Deployables

Smaller platforms (Smallsats and CubeSats)

- Enables constellations for greater spatial and temporal coverage – new kinds of measurements

Signals of Opportunity

Advanced Information Systems Technologies - Strategy

Data Science and Analytics

New Observing Strategies – Distributed S/C Missions (DSM)/Sensor Webs, Intelligent Collaborative Constellations - enable new and improve existing science measurements, reduce cost of future Missions – per new Decadal Survey – New Observing Systems

Analytic Center Framework – facilitate access, integration and understanding of disparate data sets via visualization and analytic tools

Technologies:

- **Big Data Analytics**
- **Cloud Computing**
- **Artificial Intelligence/ Machine Learning**
- **Autonomous Decision Making**
- **Onboard Computing**
  - **High Performance Space Processors**

Dec. 3, 2018 – SSO-A SmallSat Express, 15 microsats, 49 cubesats

"There are waves breaking around us
And we need to learn how to surf"
- TZ

Outlook

- ***Currently in a Technology Renaissance***
- ***Miniaturized intelligent instruments, smaller platforms and access to space are enabling new kinds of measurements – observing systems***
- ***Smallsats/CubeSats are, in some cases performing just as well as the larger missions – complementary***
- ***Commercial Sector is playing a more important role***
- ***Partnering with commercial sector, OGAs and our international cohorts are crucial***

Future is bright for affordable sustainable Earth Observations

Thank You!!!!!

- Organizers, presenters and attendees
- Not the same as in person, but on the bright side:
  - ESTF was taped – If there's something you missed or would like to review you can
  - Increased participation – 3x the usual amount of attendees
- We would greatly appreciate your feedback – survey
- We hope to see you in person next year
  - likely Caltech, with panels, posters and more plenary speakers
- *NASA NEWS* – HQ building to be named after Mary Jackson – 1st Female African American engineer at NASA

There’s a lot changing in our environment….

…Innovate and

EXPLORE
with us