Sat Technology Partnerships Tech Expo

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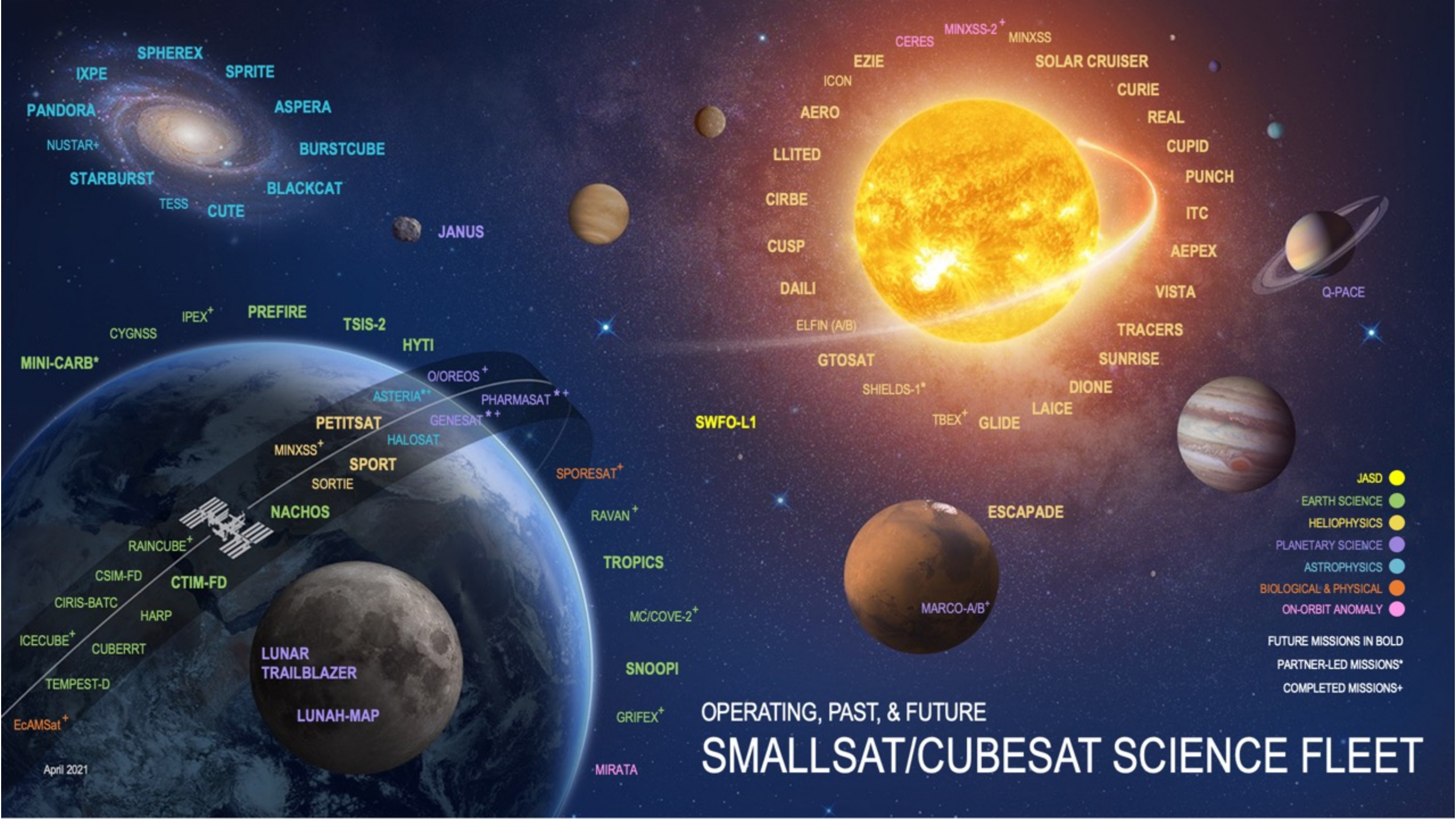


OPERATING, PAST, & FUTURE

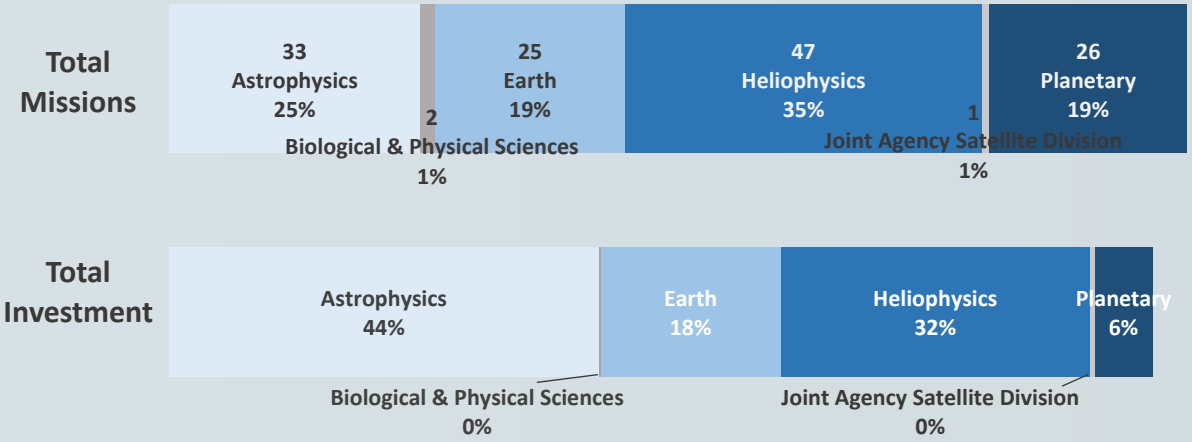
SMALLSAT/CUBESAT SCIENCE FLEET

NASA's Science SmallSat Missions at a Glance

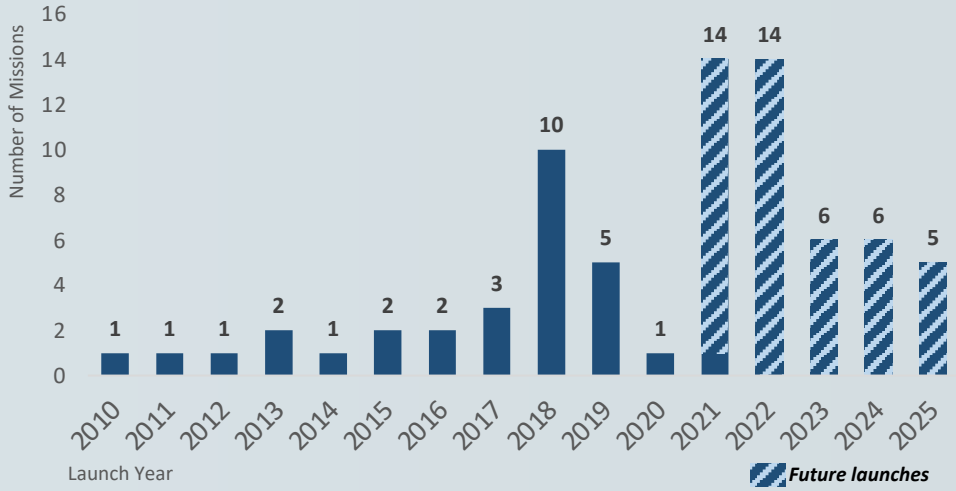
Inclusive Missions and Studies

Data as of April 2021

SmallSat/CubeSat Missions by Division



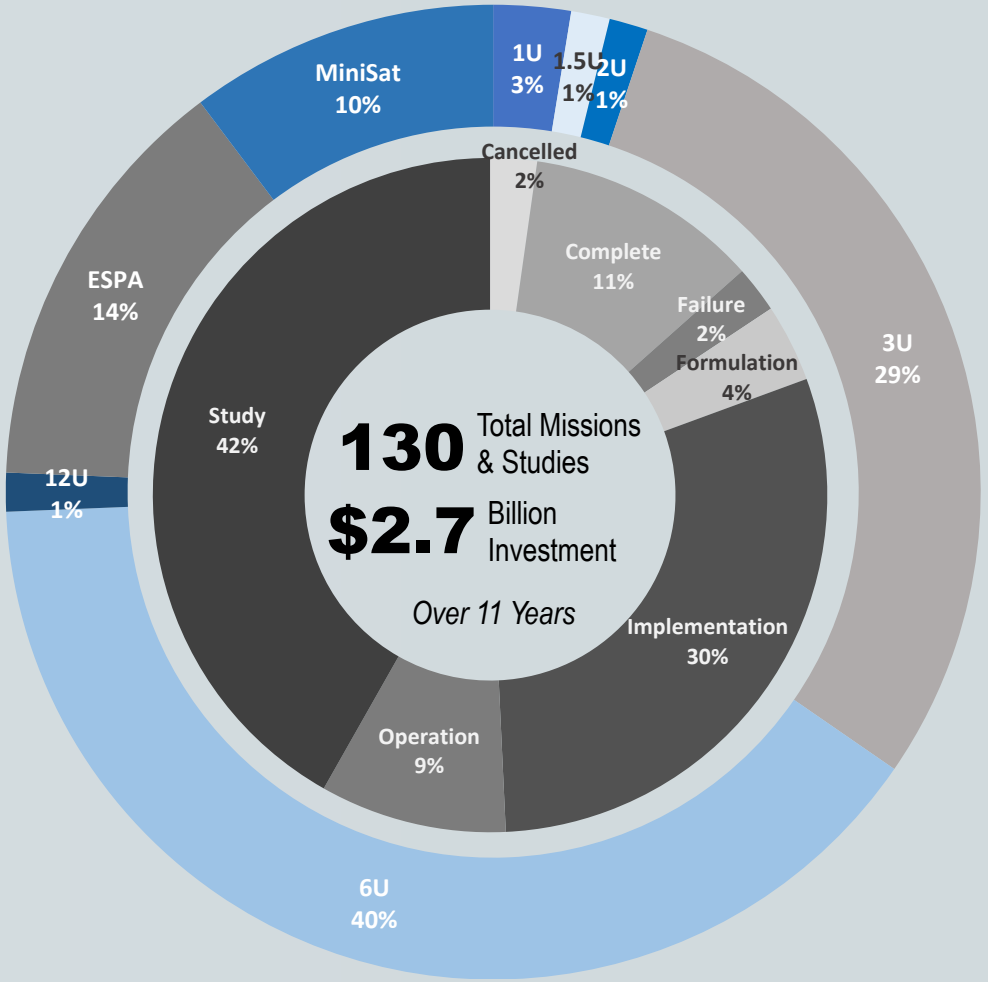
Mission Launch Timelines



45 SmallSat Missions (68 Spacecrafts) in Formulation/ Implementation 2021 and beyond

$ 1.76B Total Investment In Future Missions

Mission Phase and Satellite Size



**Data inclusive of missions solicited or directed from 2010-2021.*

Why SmallSats?

The Promise of SmallSats

- **SmallSats as a balanced program of discovery, increasing our science capabilities**
- New platforms, systems, architectures to enable unique science observations, quicker temporal measurements, data analytics and data fusion, rapid overflights
- Maximizing science return on investment – *imagine the possibilities at the fraction of cost*
  - ***Utilizing Rideshare and dedicated launch vehicles to optimize access to space:*** The IMAP mission has manifested four rideshare missions: GLIDE, Lunar Trailblazer, Solar Cruiser, and SWFO-L1 and the Psyche Mission manifested the Janus spacecrafts
  - ***Utilizing novel architectures such as constellations:*** Multipoint science measurements are significantly more affordable through the use of SmallSat/CubeSat constellations such as CYGNSS, MarCo, TROPICS, TRACERS, PUNCH, ESCAPADE, Janus, PREFIRE and SUNRISE.
- **SmallSat as platform to train and develop our future workforce**
- **SmallSats to perform Technology Demonstration for future risk reduction**

CSIM-FD

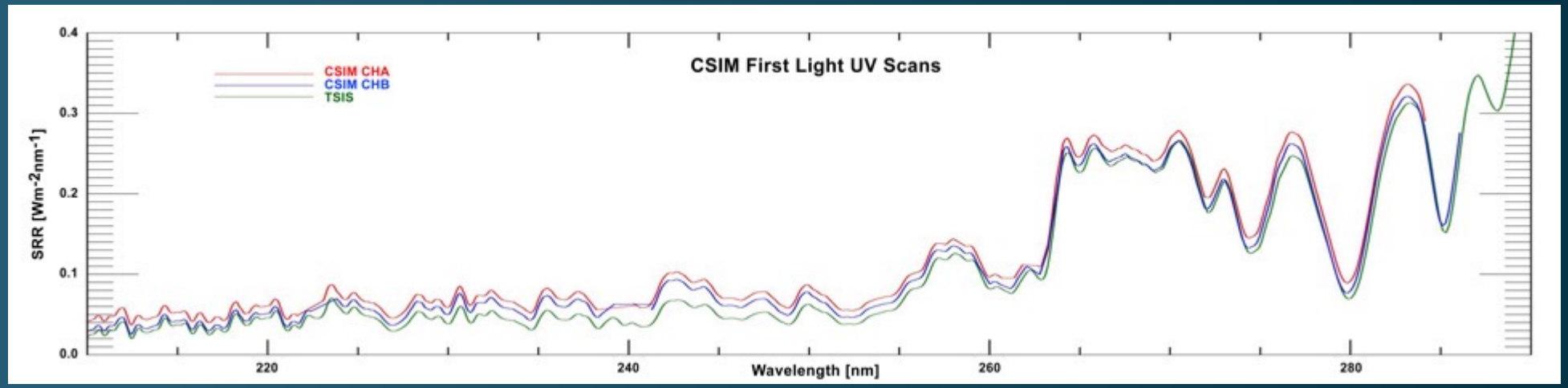
Compact Solar Irradiance Monitor Flight Demonstration

Measuring solar spectral irradiance (SSI), and how solar variability impacts the Earth's climate, contributing to long-term continuity measurements from SORCE SIM and TSIS SIM

CSIM is 11 kg based on a Blue Canyon Technologies bus

TSIS-1 is 363 kg built by LASP mounted to the ISS

SORCE is 290 kg based on an Orbital LEOStar-2 bus



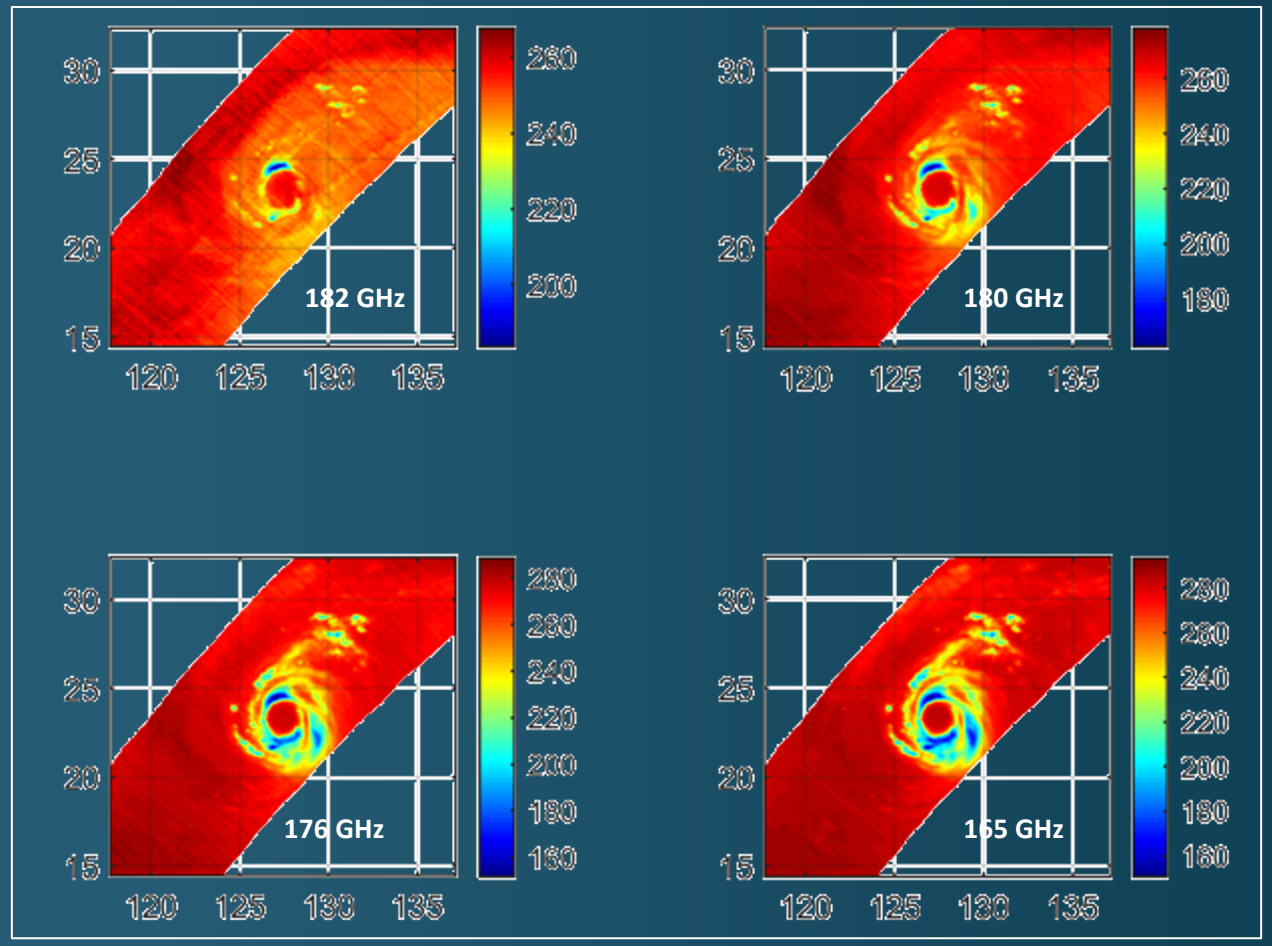
UV comparison of the first CSIM scan showing excellent agreement to the TSIS spectrum

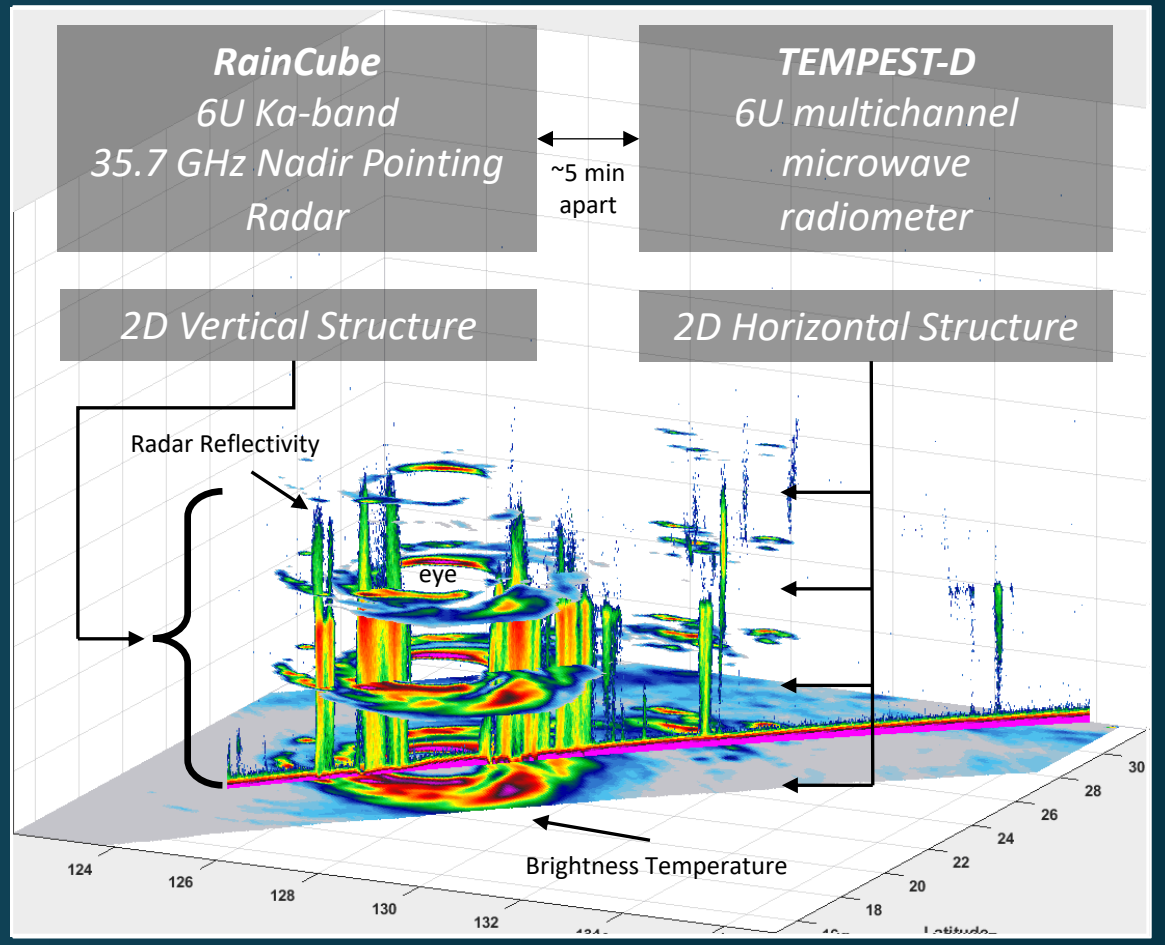
Uncorrected CSIM data (channels A and B) compared to TSIS data in a portion of the UV spectrum

A truly disruptive technology: CSIM-FD provides affordable approach to sustainable measurements for continuity measurements for irradiance monitoring

RainCube/TEMPEST-D Observing Typhoon Trami

Spacecraft constellation separated by 5 minutes revealing 3D storm structure





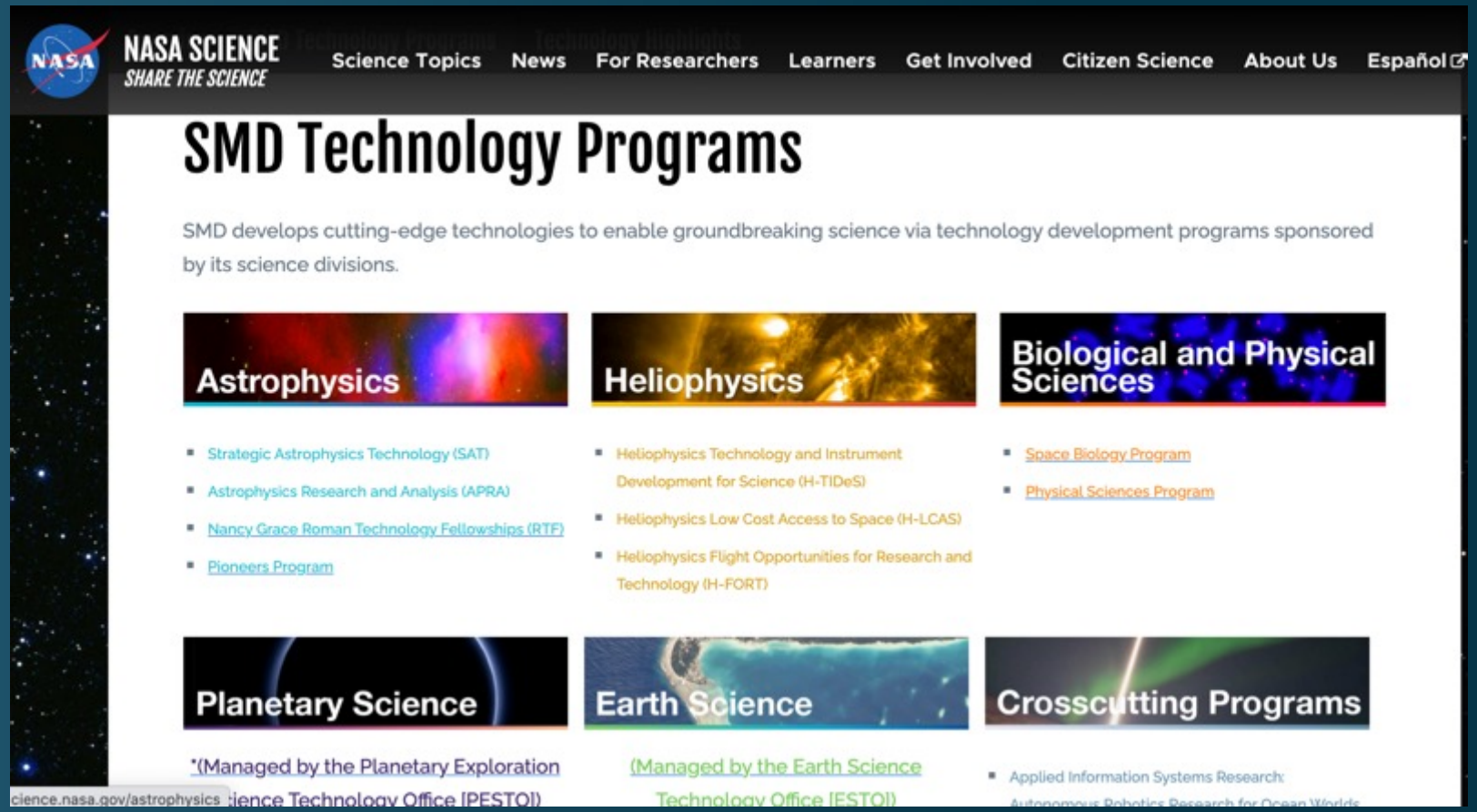
First heterogeneous constellation measurement: Complementary nature of RainCube and TEMPEST-D missions create new path of observations to augment our measurements and increase our science capability.

Challenges

- Low SWaP miniaturized of sensors and payload pipeline technology development, culminating in a rigorous demonstration program.
- Small satellite subsystem technologies have rapidly matured; focused investments and strategic partnerships needed to advance technologies for deep space ESPA-class systems.
- Propulsive ESPA is an enabling technology for complex multi-spacecraft science missions, but flight demonstrations are needed to prove and mature this capability
- Drag modulated aerocapture enables more resiliency to launch targets
- Industry has advanced rapidly to provide turn-key reliable, global, high-bandwidth, secure solutions for communications for SmallSats and CubeSats, especially in LEO; radio compatibility, licensing and encryption remain challenging for our PIs
- Conjunction Risk for Autonomous operations especially in light of the rise of the Mega-Constellations
- New insights from multi-instrument constellation data fusion and analytics
- Cooperative synergies among large and small missions.

SMD SmallSat and Technology

SMD Technology Programs sponsored by our divisions:
https://science.nasa.gov/technology/smd-technology-programs



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