National Aeronautics and Space Administration

NASA

EXPLORE

Protecting our Home Planet with SmallSats

Florence Tan
Chief Technologist (Acting)
Science Mission Directorate (SMD)
Chair, Small Spacecraft Coordination Group
NASA Headquarters

AGU 2021

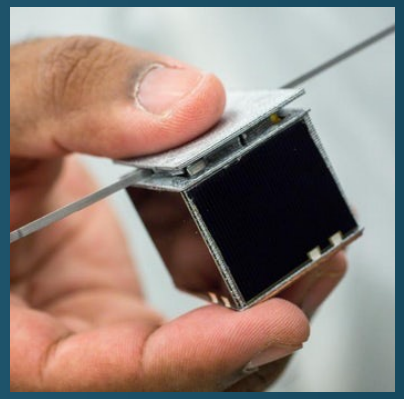



Google Earth Timelapse
Dubai, UAE
1984
Google Earth Timelapse (Google, Landsat, Copernicus)

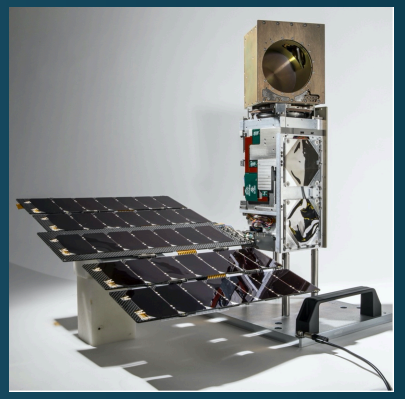

AMAZON DEFORESTATION
May 2017—Sep 2020
planet.
American Football Field
0.5 mi
0.5 km
2017
2018
2019
2020

Fundamentals of Small Spacecraft

Spectrum of Satellite Development



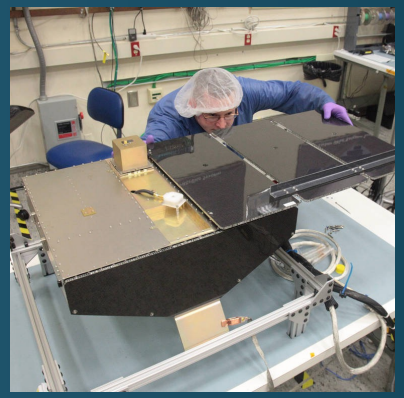
Picosatellite
PocketSat (0.1 – 1 kg)



CubeSat/Nanosatellite
TROPICS 3U/6U (1 – 10 kg)



ESPA-Ring
Payload Port Limit (450 kg)



Microsatellite
CYGNSS (10 – 100 kg)



Small Satellite
ESCAPADE (100 – 500 kg)

SMD Handbook Definition: SmallSat

A spacecraft that is interface compatible with an ESPA Ring, a dedicated small or medium-lift launch vehicle, or a containerized dispenser, and with an upper mass limit of approximately 500 kg



ISS



Rideshare



Dedicated

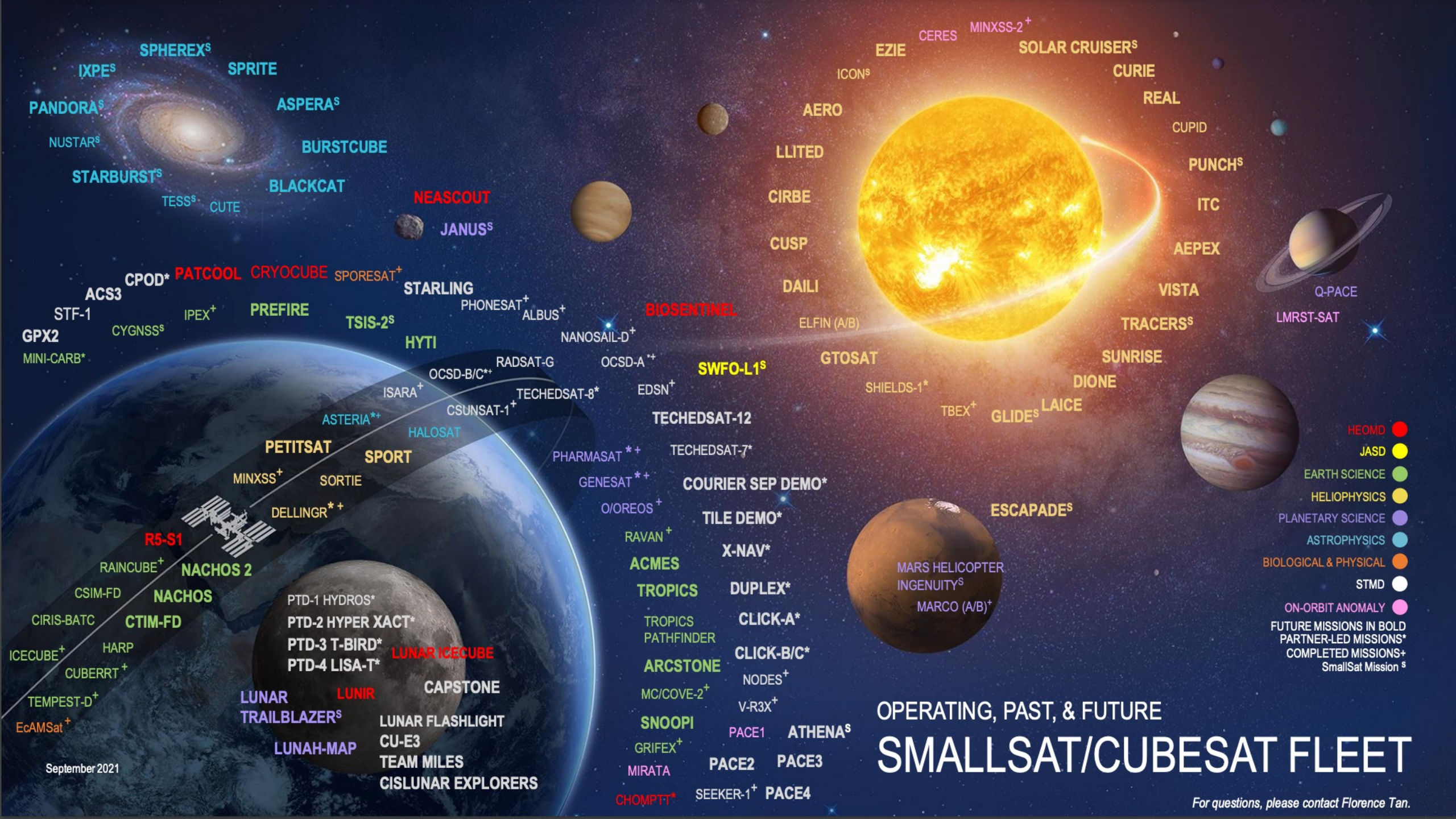
Aug. 4, 1971 – Apollo 15 Particles and Fields Subsatellite (PFS-1) carrying a Magnetometer, a Charge Particle Detector, and an S-band transponder, released from the Service Module prior to Lunar Orbit Departure

APOLLO SUBSATELLITES



Pictured: Apollo 15 astronauts, David Scott, Alfred Worden, and James Irwin

The Apollo 15 PFS-1 studied plasma, particle, and magnetic field of Moon's environment and mapped lunar gravity field



OPERATING, PAST, & FUTURE

SMALLSAT/CUBESAT FLEET

For questions, please contact Florence Tan.

KEY SCIENCE THEMES

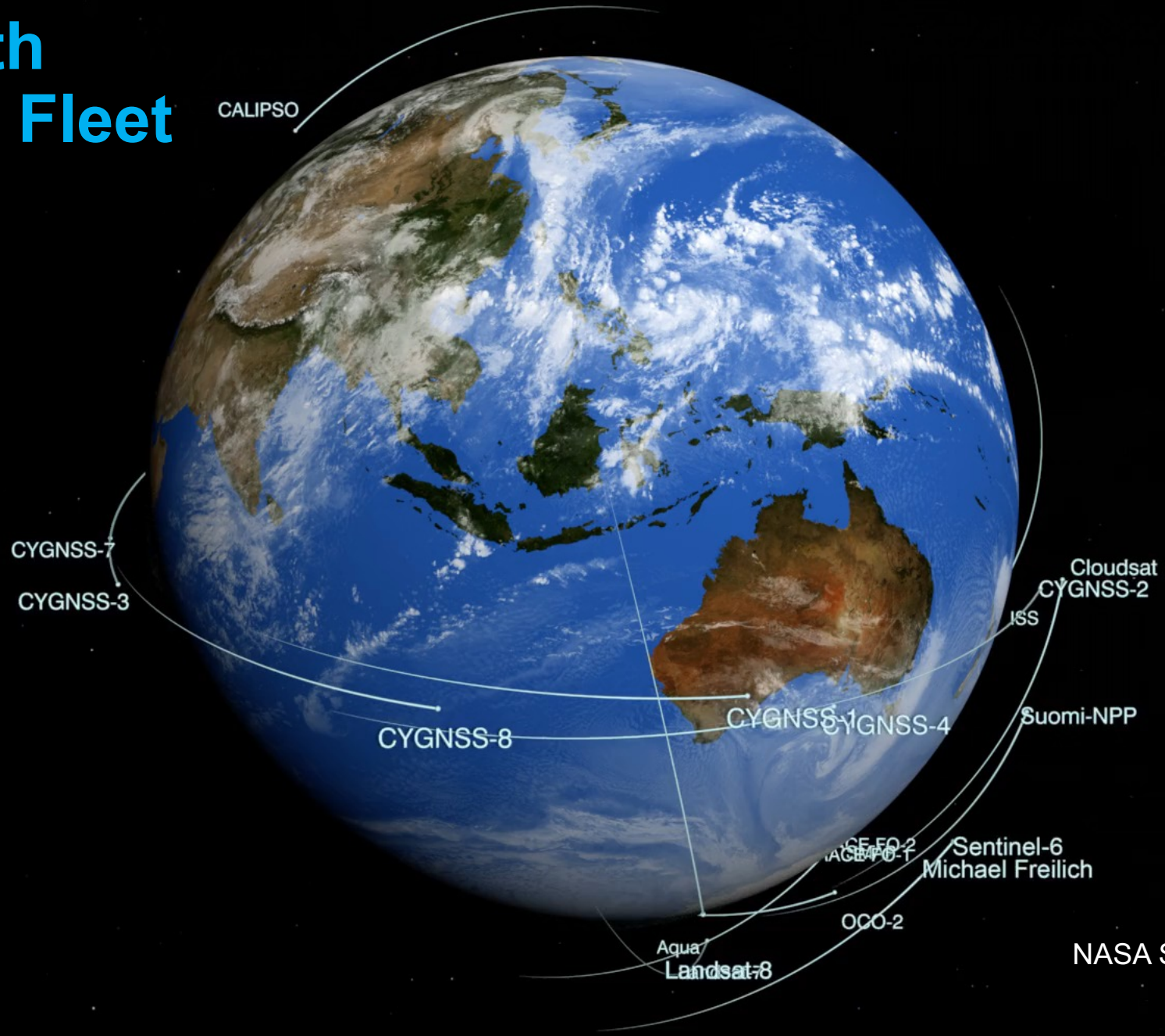


PROTECT AND IMPROVE LIFE ON EARTH AND IN SPACE

SEARCH FOR LIFE ELSEWHERE

DISCOVER SECRETS OF THE UNIVERSE

NASA Earth Observing Fleet

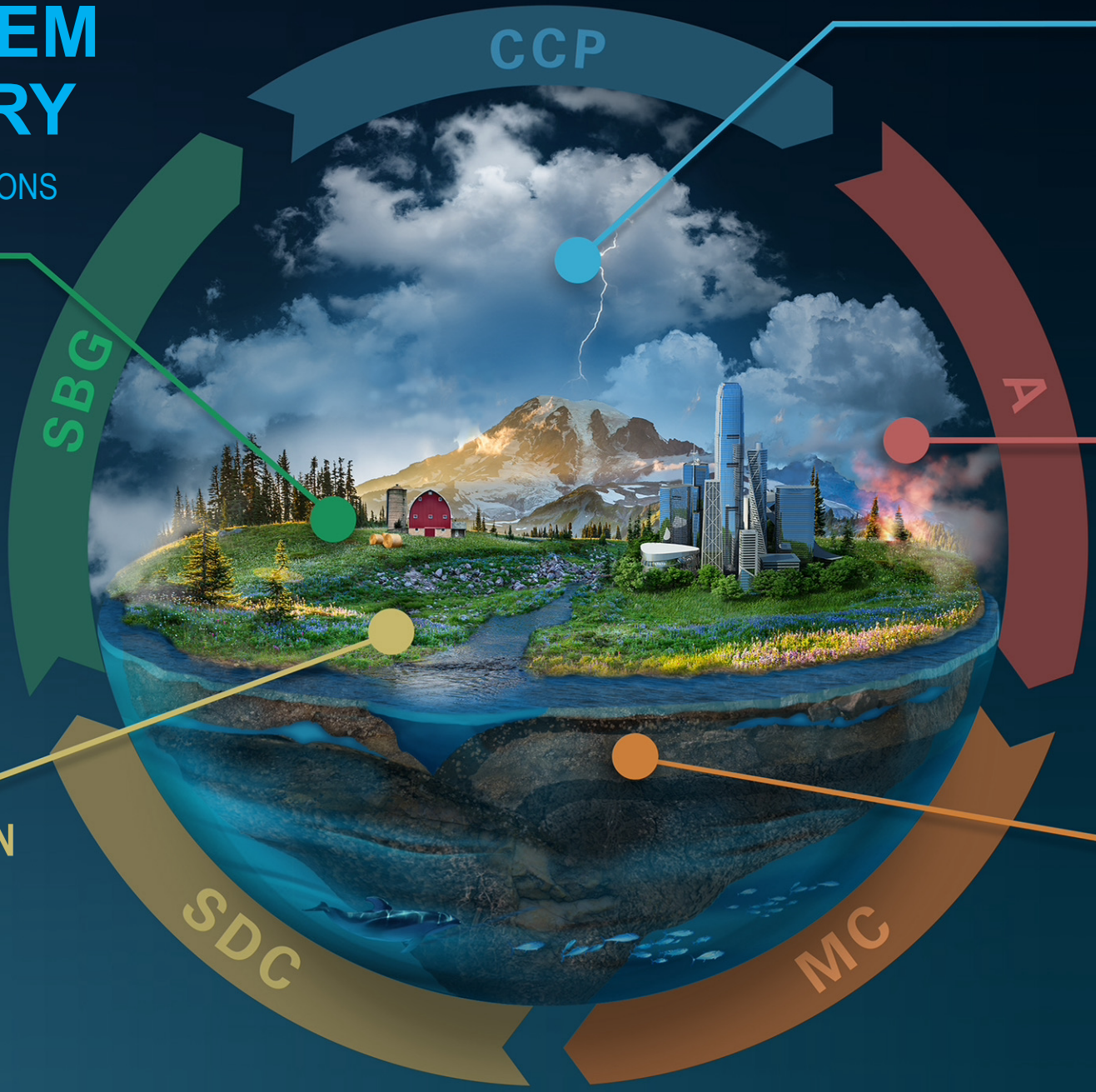


August 2021

NASA Scientific Visualization Studio
svs.gsfc.nasa.gov/4931

EARTH SYSTEM OBSERVATORY

INTERCONNECTED CORE MISSIONS



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

SURFACE BIOLOGY AND GEOLOGY

Earth Surface and Ecosystems

AEROSOLS

Particles in the Atmosphere

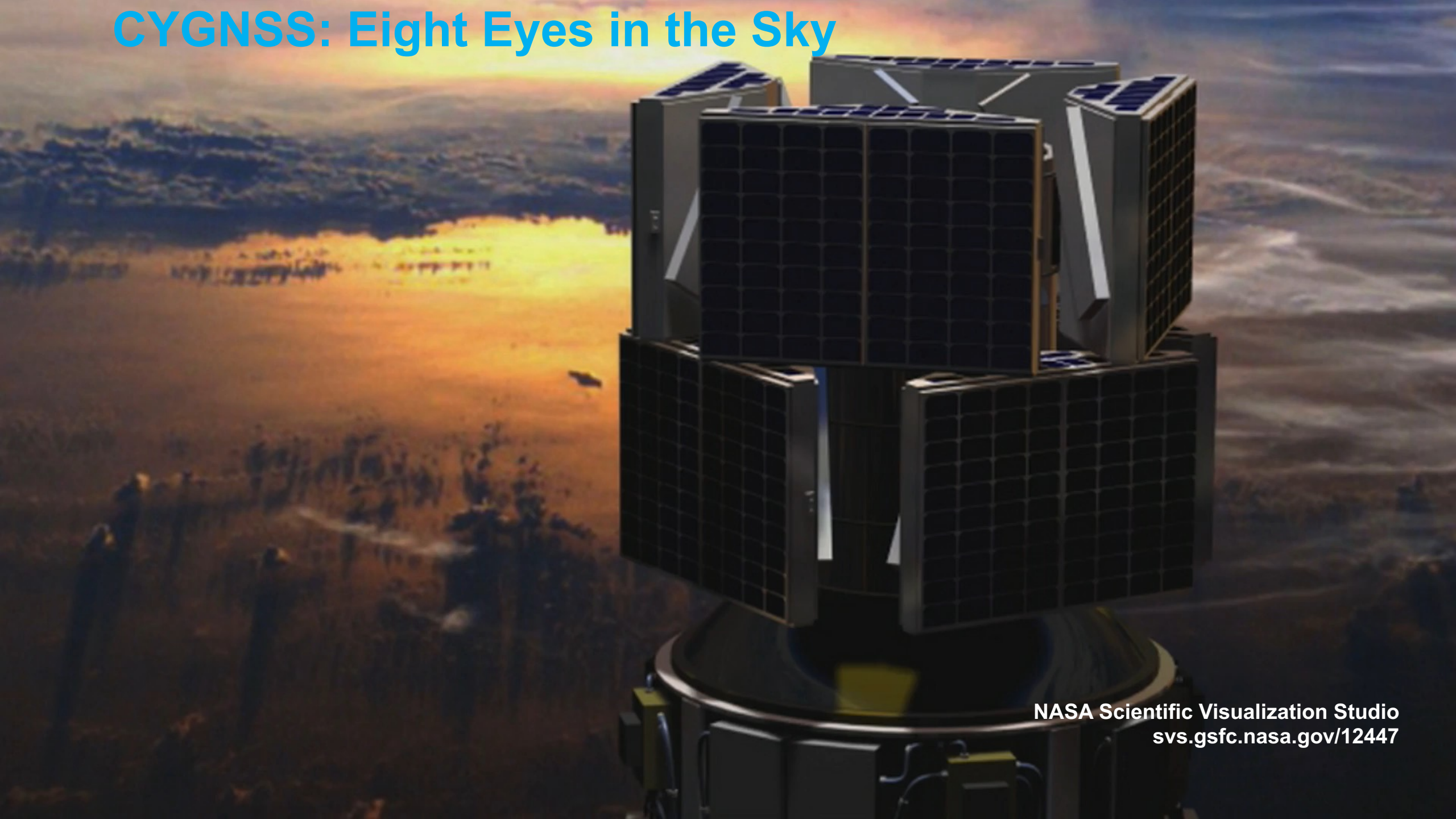
SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

MASS CHANGE

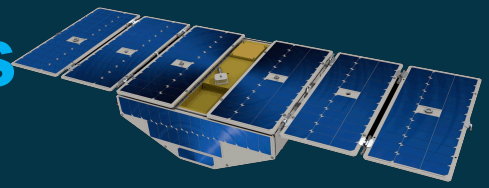
Large-scale Mass Redistribution

CYGNSS: Eight Eyes in the Sky



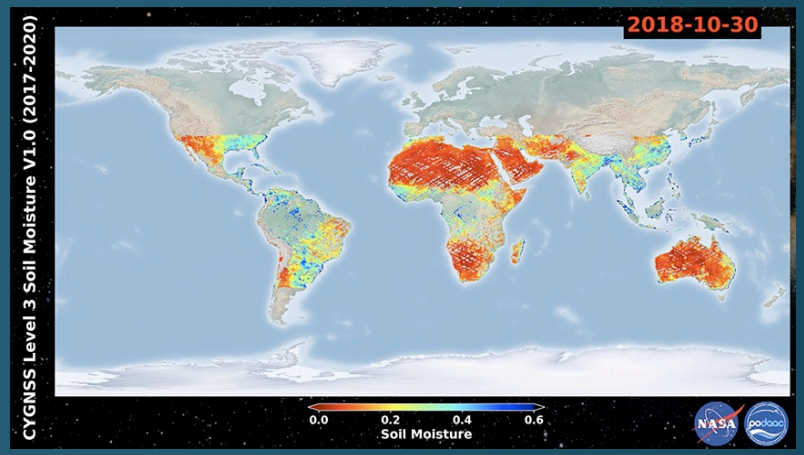
NASA Scientific Visualization Studio
svs.gsfc.nasa.gov/12447

CYGNSS Scientific Results and Applications



Daily soil moisture data product

- Oct. 30, 2018



Map flood inundation after hurricane landfall

- Reflectivity before and after Hurricane Isaias landfall, July-August 2020

Before landfall



After

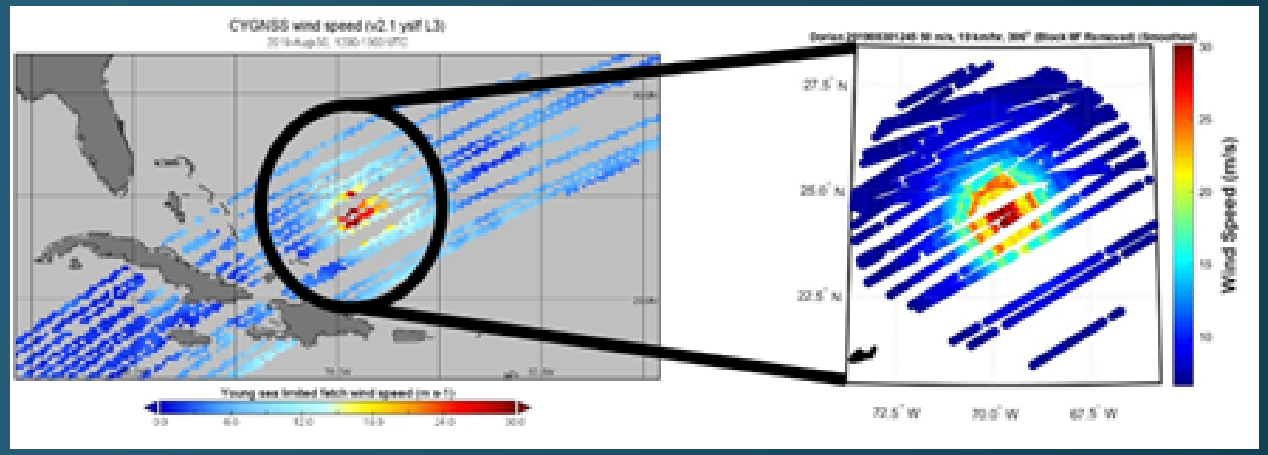


Delta



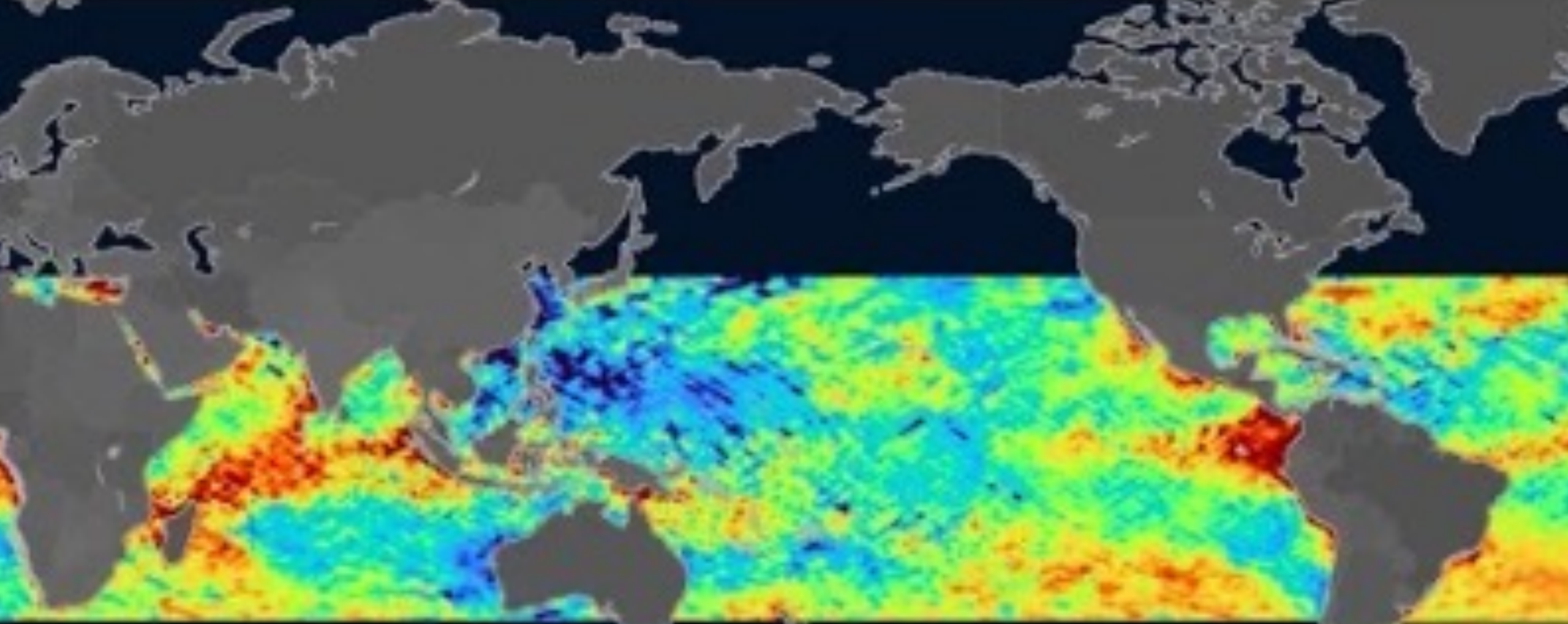
Measure winds in tropical cyclones

- Hurricane Dorian overpass, Aug. 30, 2019 at 02:45 UTC





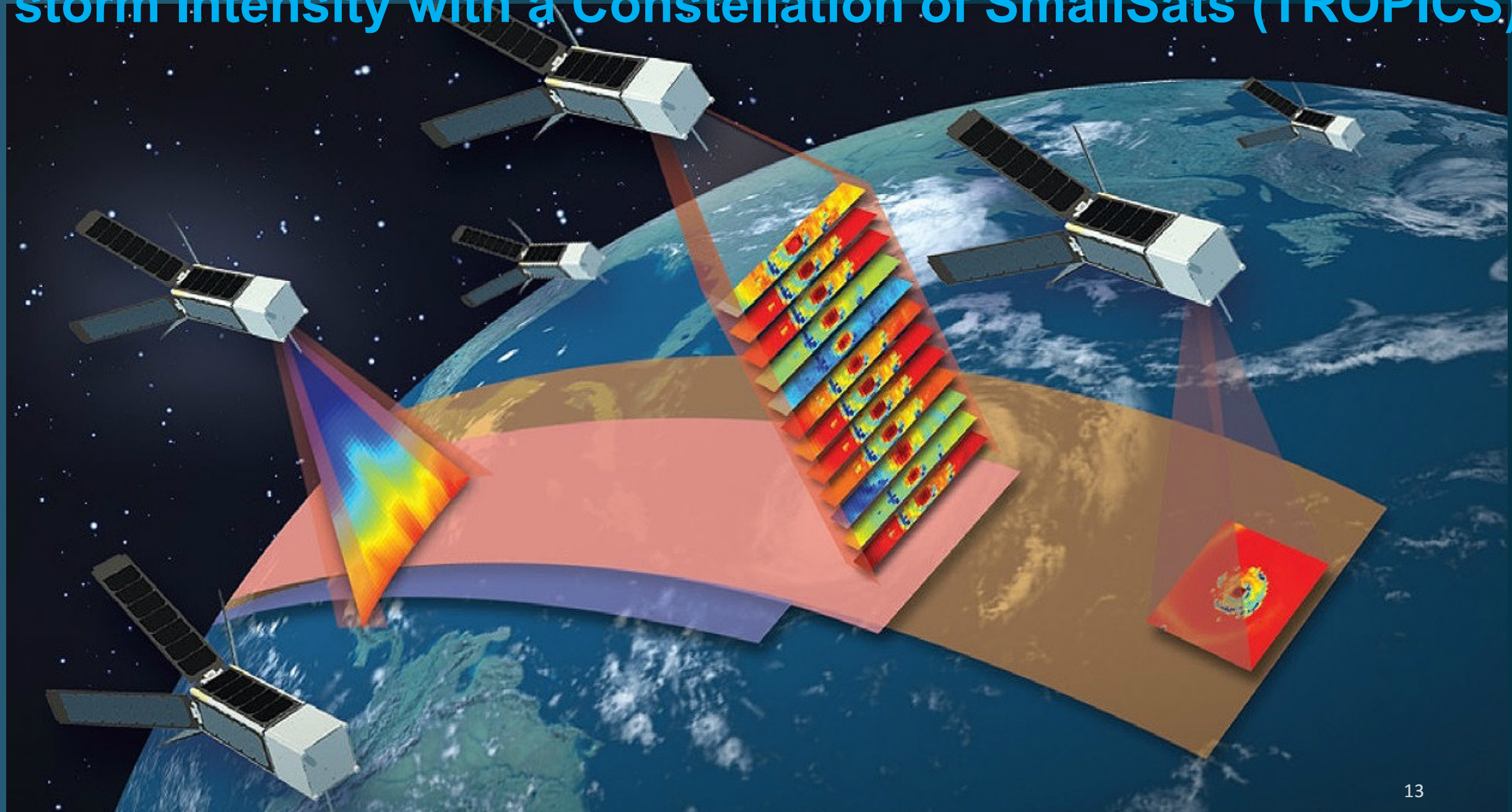
Extensive flooding in the Dominican Republic



CYGNSS: Observations of sources of ocean microplastic from space

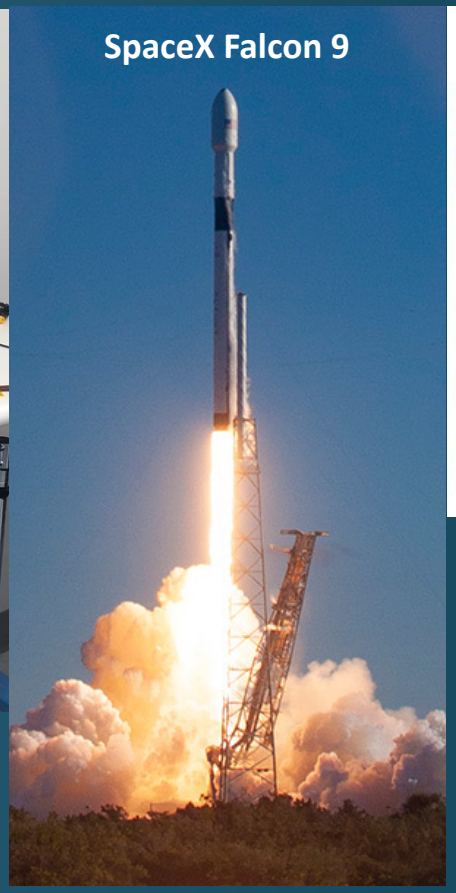
https://www.youtube.com/watch?v=sQTGOU9LiJ0&t=5s

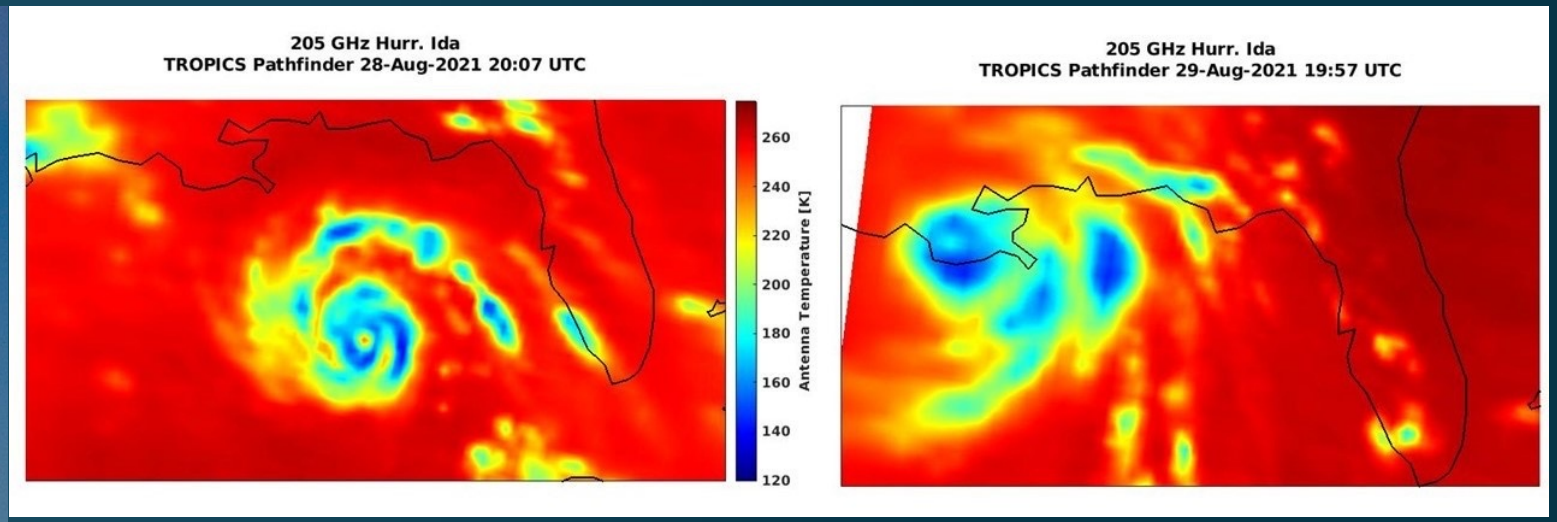
Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of SmallSats (TROPICS)



TROPICS Pathfinder (Qualification Unit) Launched June 30, 2021





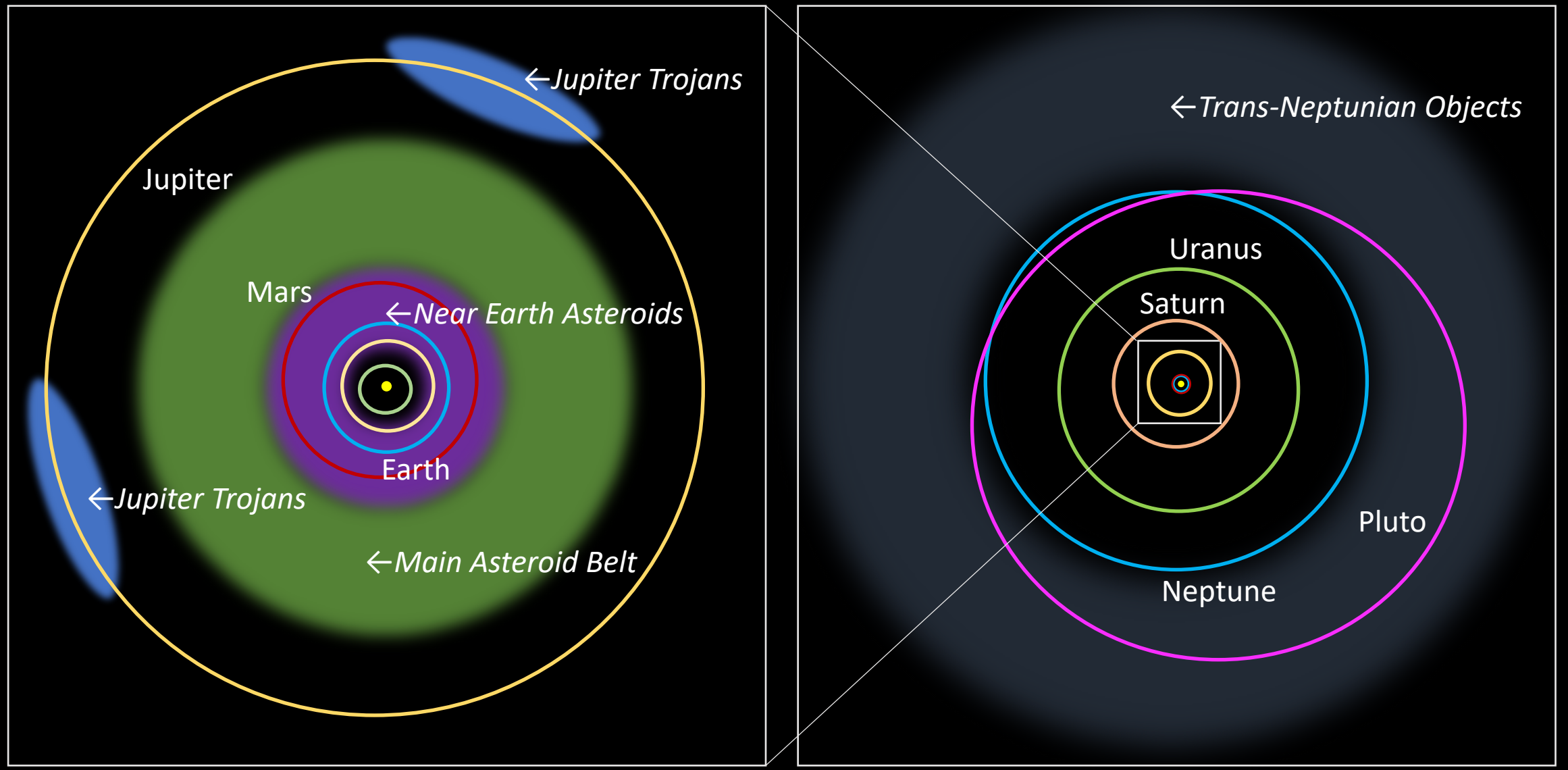


Imagery of Hurricane Ida Before/After Landfall @ 205 GHz

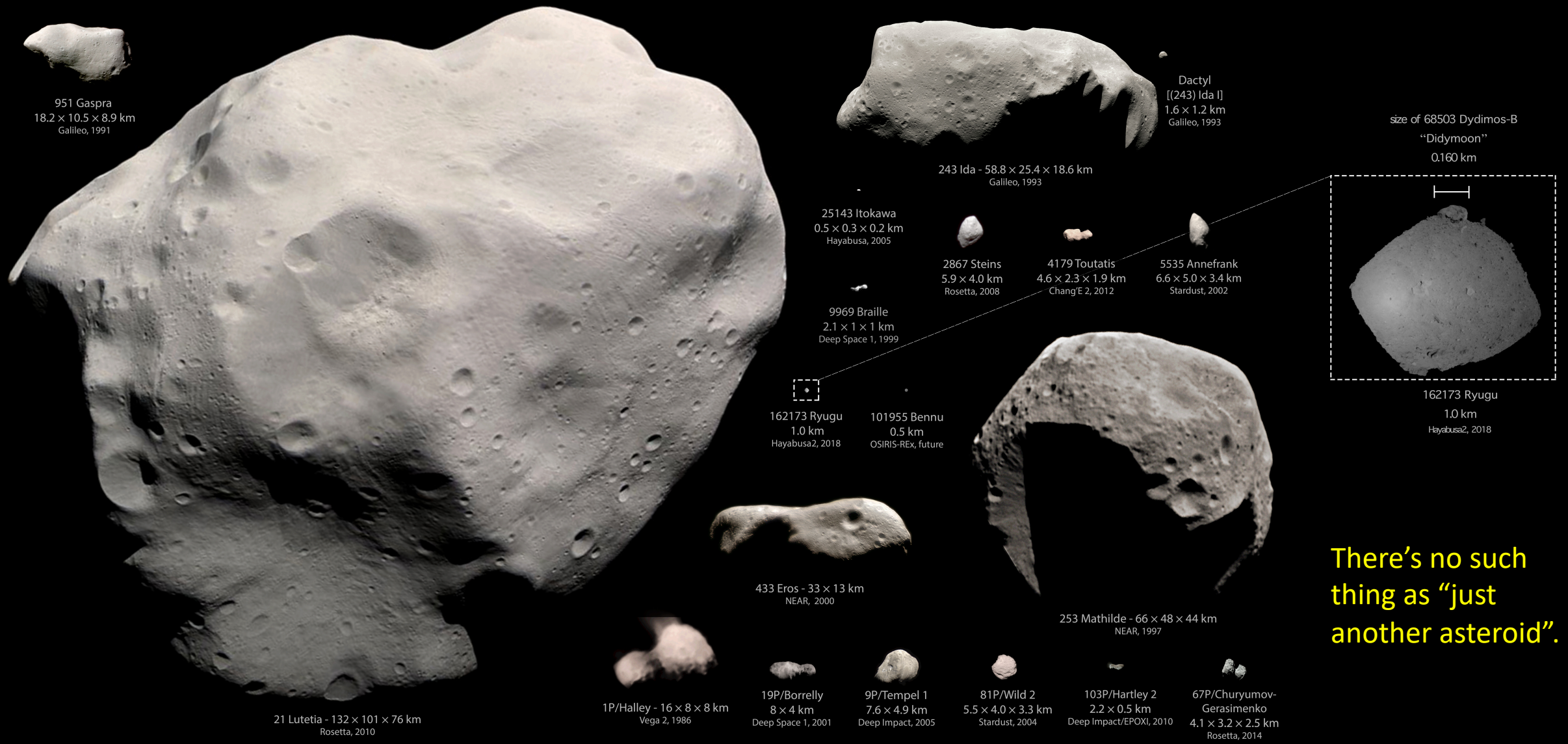
- Sun-synchronous orbit; 530 km altitude; 2:00 pm LTDN
- Satellite has been contacted and in excellent health

Rotating microwave radiometer 1U Payload: 7 channels near 118 GHz, 3 near 183 GHz, and imaging at 89 and 205 GHz, with articulating 5-panel solar array

Different Asteroid Populations Tell Distinct Stories About our Solar System's History



Asteroids and Comets Seen Up Close by Spacecraft



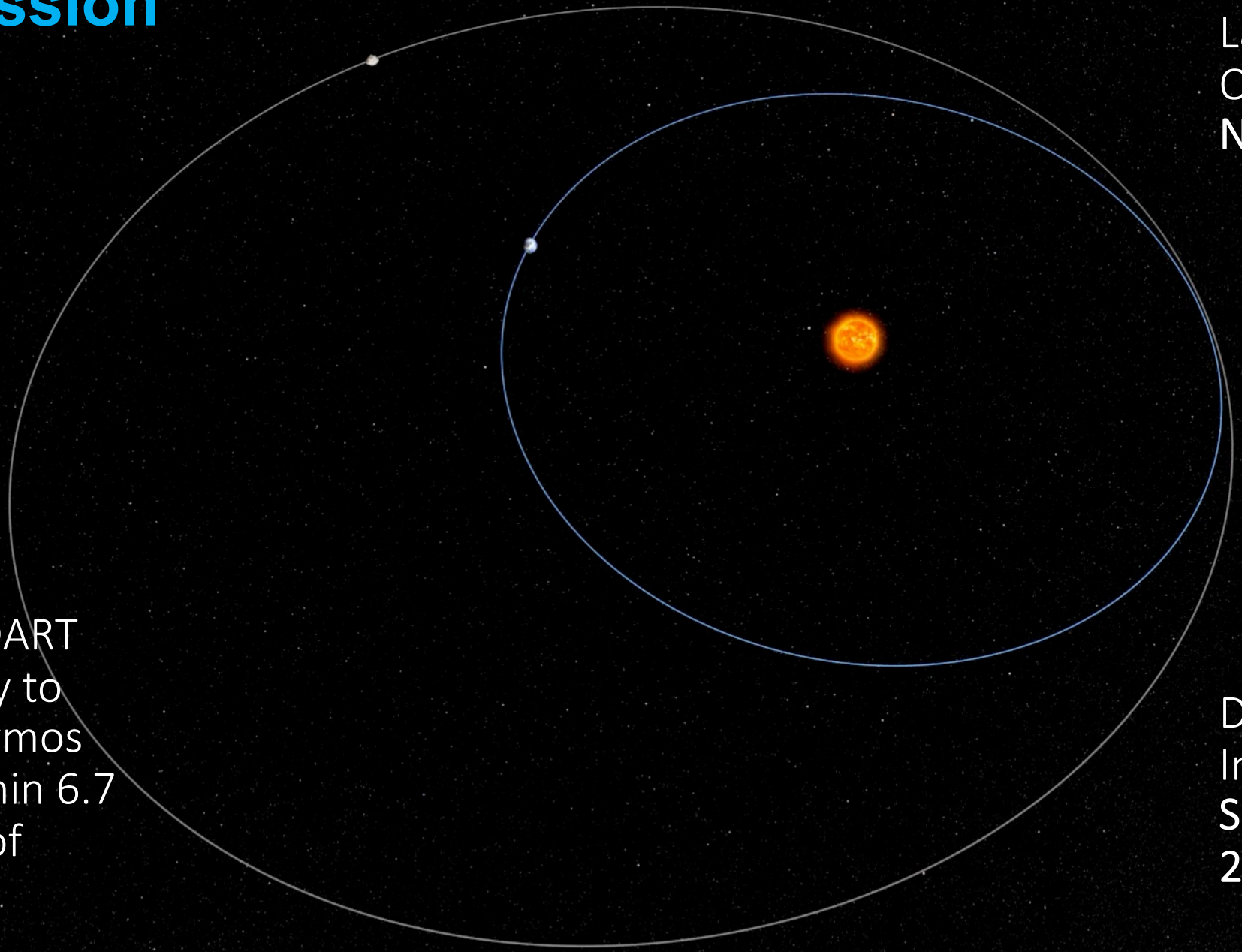
There's no such thing as "just another asteroid".



DART is the first full-scale flight demonstration of an asteroid deflection technology: kinetic impact

NASA's DART Mission: Learning to Defend Earth from Asteroid Impacts

DART Mission Profile



Launch Window Opens:
Nov. 23, 2021

Launch puts DART on a trajectory to intercept Didymos when it is within 6.7 million miles of Earth

DART Kinetic Impact:
Sept. 26 – Oct 2, 2022

Double Asteroid Redirection Test Mission (DART) / LICIACube

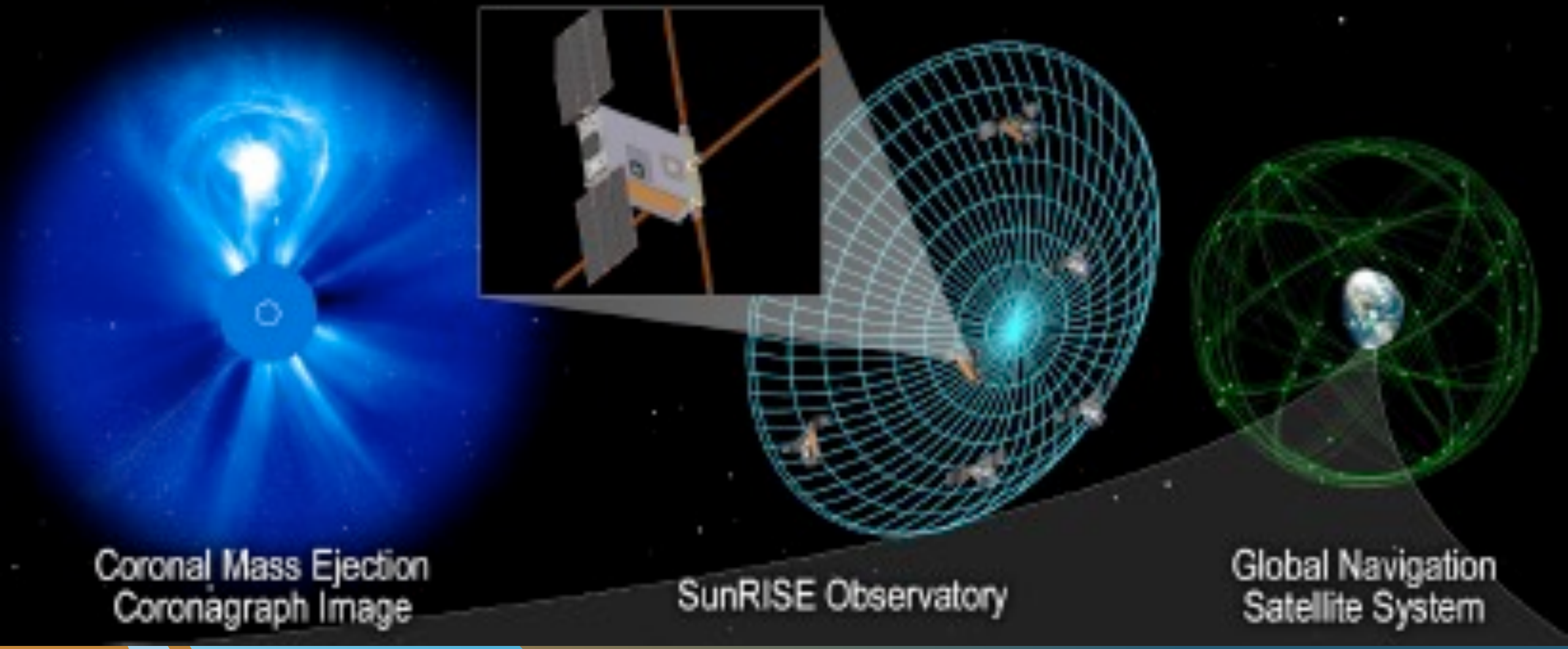


Heliophysics Explorer

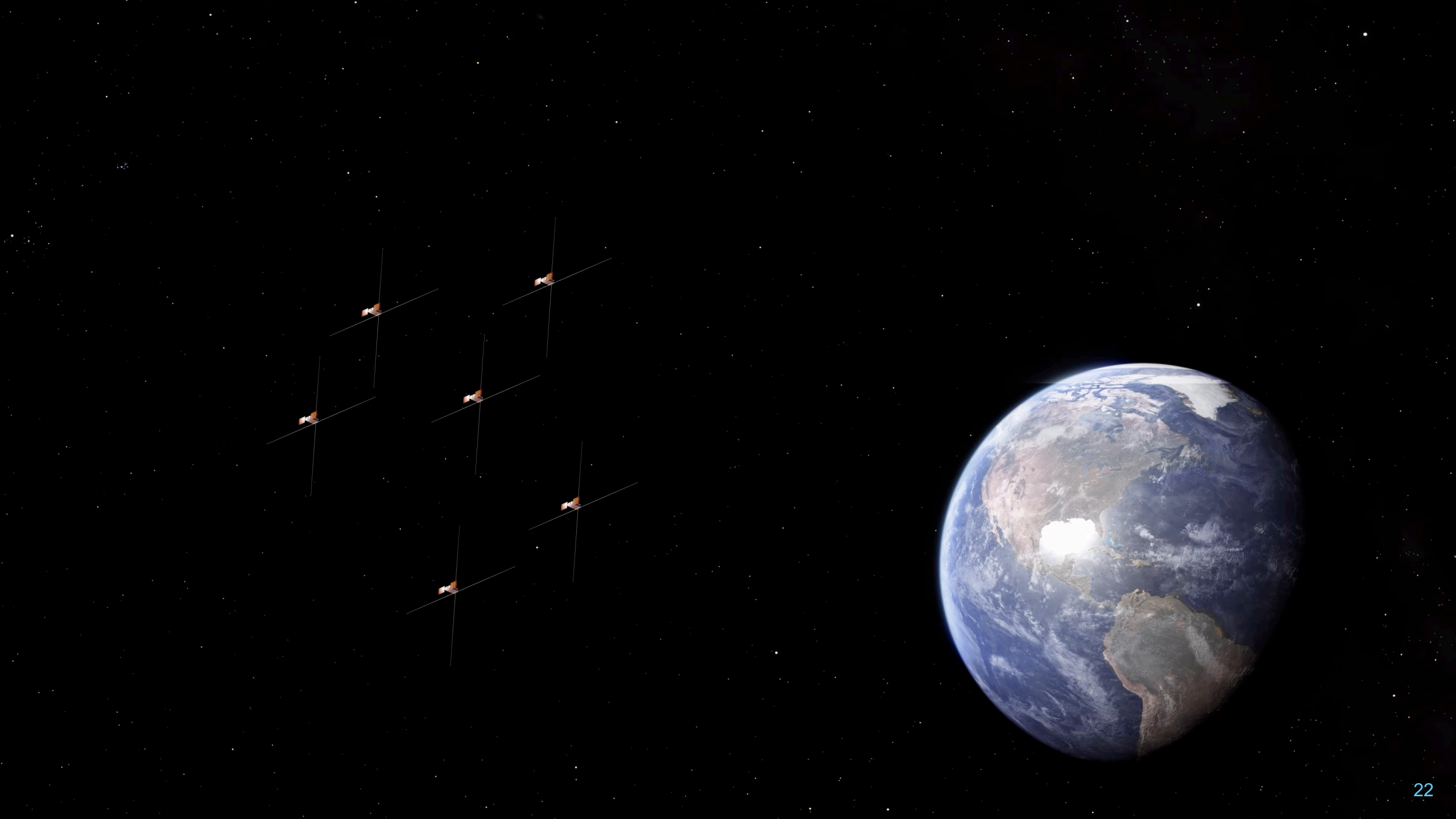
Sun Radio Interferometer Space Experiment (SunRISE)

PI: Justin C. Kasper/University of Michigan

SunRISE
Sun Radio Interferometer Space Experiment








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