

A large image of Earth from space, showing the Americas, with a bright comet streaking across the dark blue sky. The text "Goddard SPACE FLIGHT CENTER" is overlaid on the image.

Goddard
SPACE FLIGHT CENTER

A Focus on the Future

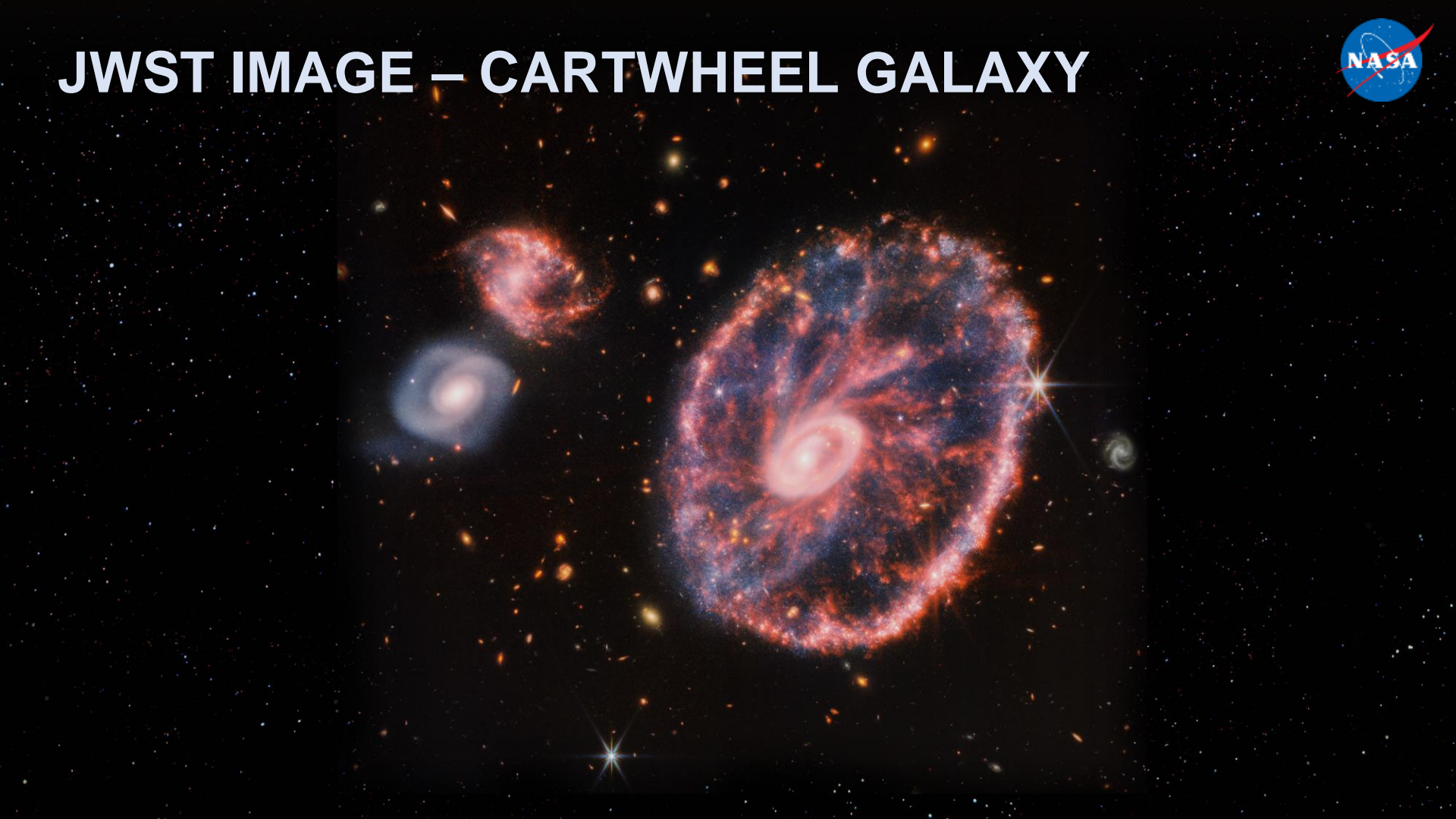
Dr. Christyl C. Johnson

Deputy Director for Technology and Research Investments

NASA Goddard Space Flight Center

August 16, 2022

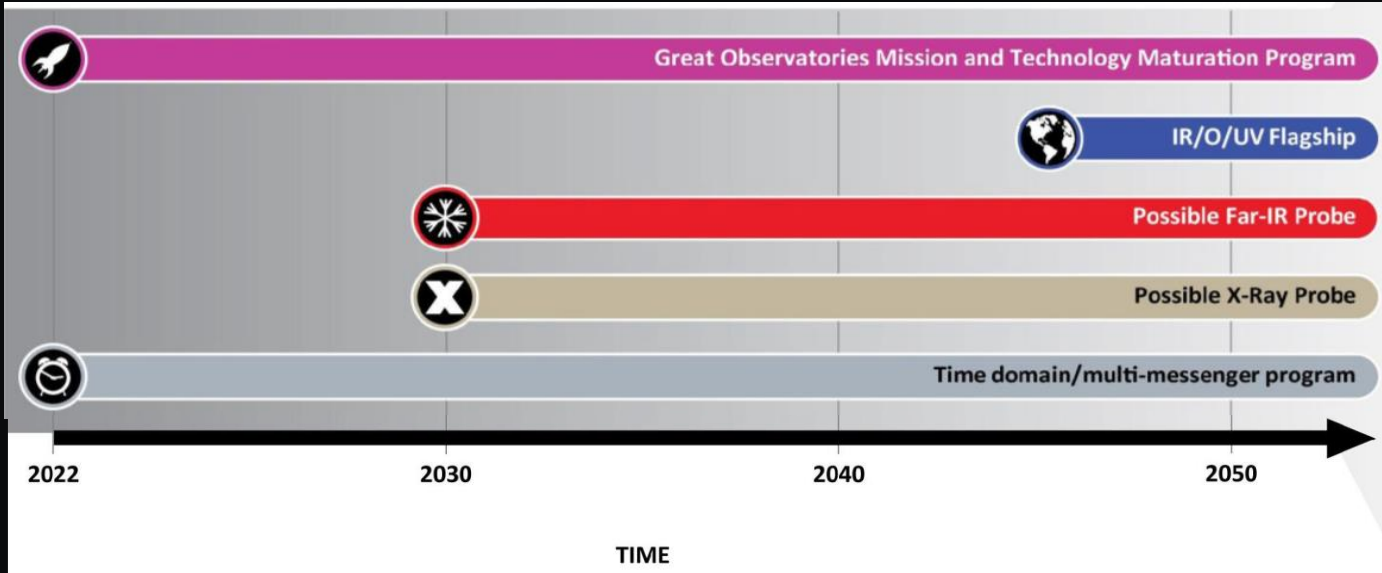
JWST IMAGE – CARTWHEEL GALAXY





Astro 2020 – Recommended New Activities for Space

The National Academies of
SCIENCES • ENGINEERING • MEDICINE
Pathways to Discovery in Astronomy
and Astrophysics for the 2020s

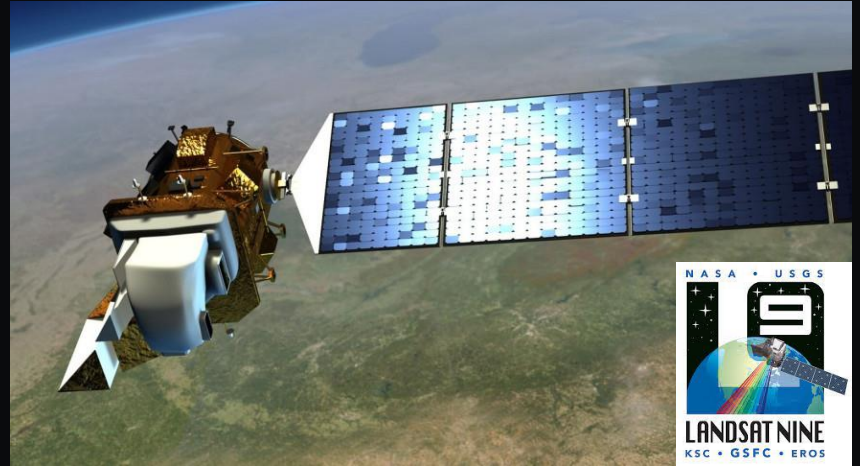
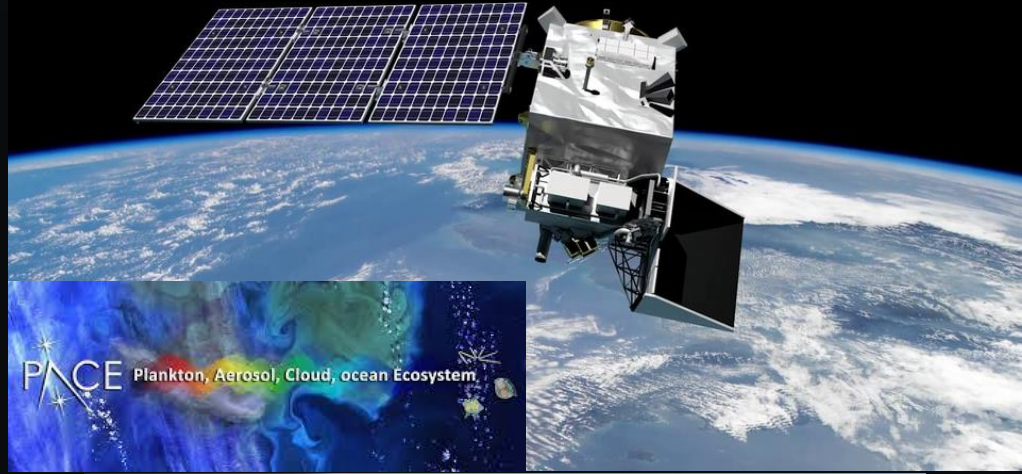


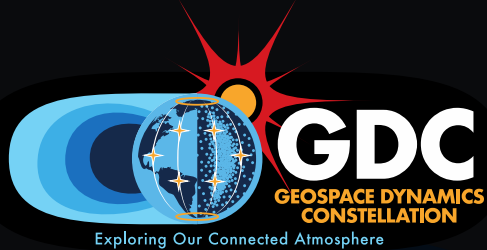
Three panels of scientific imagery, each with a set of icons on the left and a title in a box on the right:

- Worlds and Suns in Context:** Shows a blue planet with a red sun. Icons include a rocket, globe, snowflake, X-ray, and various astronomical symbols.
- New Messengers and New Physics:** Shows a glowing orange ring. Icons include a rocket, globe, snowflake, X-ray, radio waves, and various astronomical symbols.
- Cosmic Ecosystems:** Shows a colorful nebula. Icons include a rocket, globe, snowflake, X-ray, radio waves, and various astronomical symbols.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

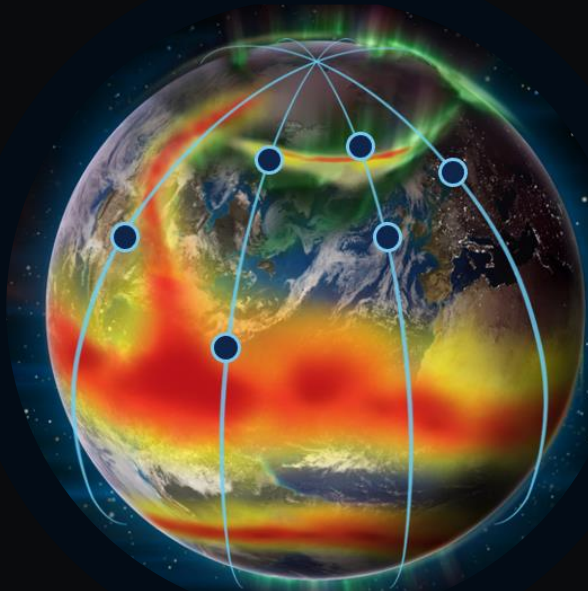
Earth Science Highlights at GSFC



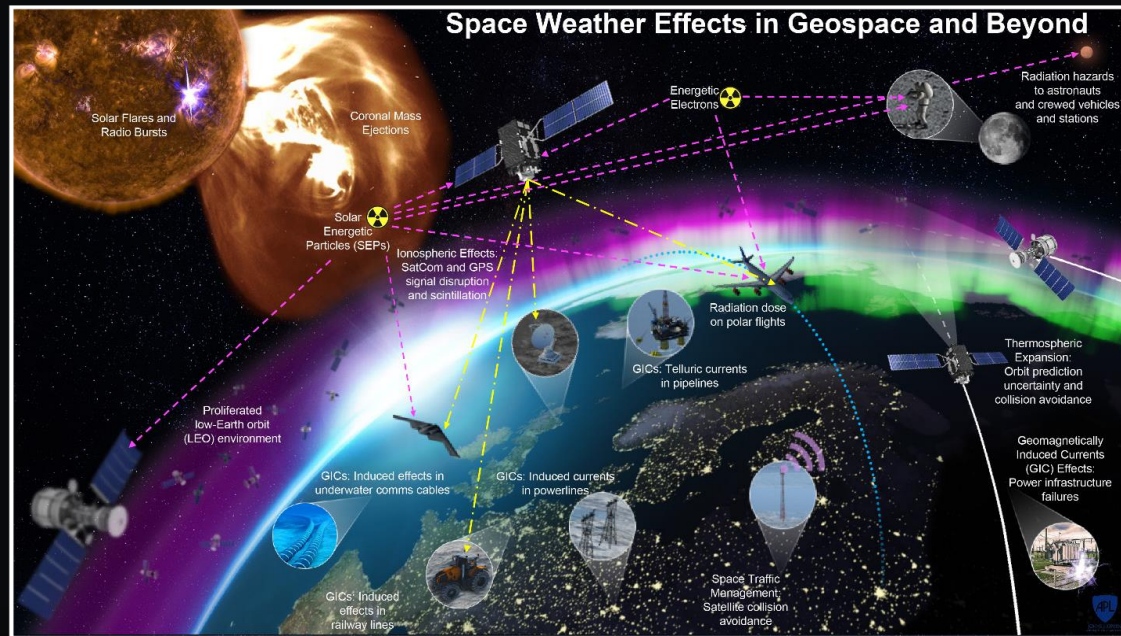


Geospace Dynamics Constellation

Understanding the drivers of space weather in LEO



SIX OBSERVATORIES PROVIDE
FIRST GLOBAL VIEW



ORBITAL DRAG

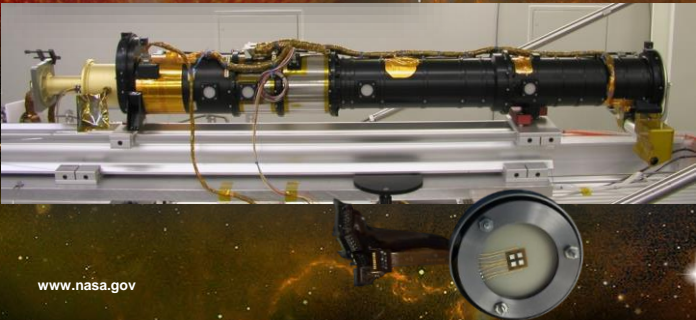
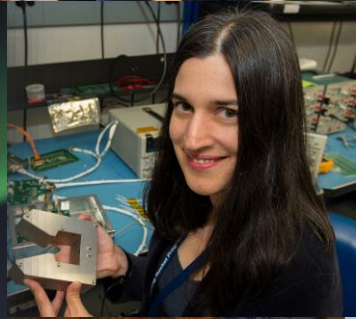
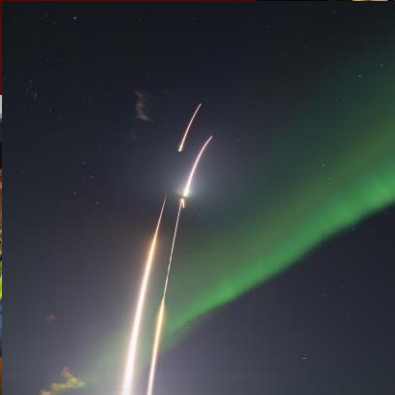
GPS/RF
INTERFERENCE

GEOMAGNETICALLY
INDUCED CURRENTS



Heliophysics Strategic Technology Office (HESTO)

Novel office to enable identification, development and infusion of new technologies to the next generation heliophysics missions.



Planetary Science at GSFC: Looking ahead to the next decade!

Asteroid and Comet Sample Return



Uranus Orbiter and Probe Ocean Worlds & the Search for Life



Artemis Systems, Lunar Orbital and Surface Science

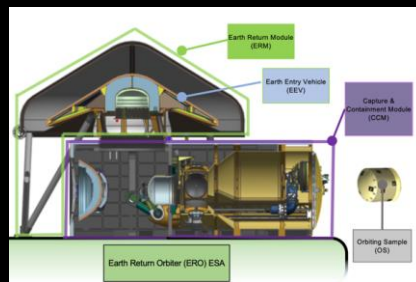


DAVINCI Mission & planetary probes

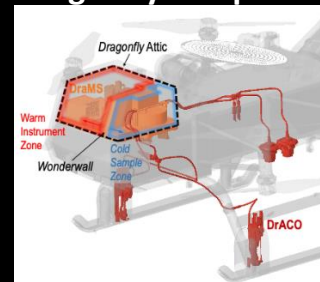
Planetary Science with JWST and future flagships



Mars Sample Return



Dragonfly Sample Suite



New Frontiers,
Discovery Planetary
Defense



In order to achieve these science objectives, we are focused on...

- Enhancing our Targeted Strategic Partnerships (including public/private partnerships)
- Advancing and Infusing our Technology Thrust Investments
- Integrating our Engineering and Technology Enhancements

Agency Updates



- **Process Improvements:**

- Open-Source Software Development: Updating Agency policy to ***reduce barriers to participation in open-source development project efforts***
 - Partner-led vs. NASA-led (NASA does not own, control, or manage)
 - Formal partnership agreement (e.g., SAA, SUA) not required
 - Anticipate release in FY23
- Partnership Agreements: New Agency-wide initiative underway to ***significantly reduce processing times*** for domestic Space Act Agreements (SAAs)
 - Customer Focused
 - Defining process metrics to track performance
 - Targeted completion by 10/31/2022

Goddard seeks areas of intersection of our unique capabilities with the activities of the DoD and IC



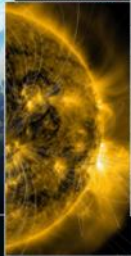
Goddard's Contributions in Space Exploration



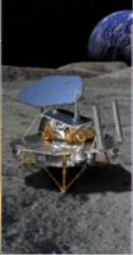
Earth Science



Heliophysics



Planetary & Lunar Science



Astrophysics

Human Exploration & Operations



Suborbital Programs & Range Services



Space Communications & Navigation



Cross Cutting Technology And Capabilities



Wallops is A Unique National Asset



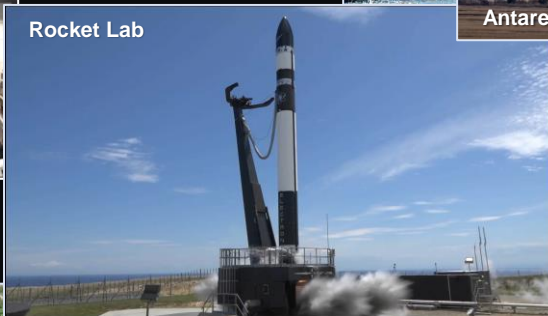
- One of only four major orbital launch ranges in the U.S. providing assured access to space, supporting NASA, DOD, OGAs, and commercial space.
- Provides unique mobile launch range capability supporting worldwide operations.



Minotaur V: LADEE Mission to the Moon



Range Control Center



Rocket Lab



Antares



Launch Pad 0A



Payload Processing Facility



UAS Runway



NASA Autonomous Flight Termination Unit (NAFTU)



- Game-changing command and control system for launch vehicle providers for use at all U.S. launch ranges - ensuring public safety during launch operations.
- Real-time execution of flight safety, replacing the functionality of ground systems and Range Safety Officer roles in monitoring performance and in-flight safety decision making.
- Autonomous Flight Termination is the keystone of the launch range of the future and a requirement for Department of Defense (DOD) launches beginning in 2025.
- NAFTU will expand launch capabilities for the entire launch industry and launch opportunities at Wallops.





Strategic Technology/Capability Thrust Areas

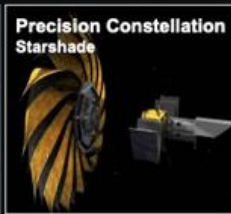
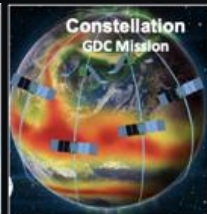
- Distributed Systems Missions (DSM)
- In-Space Servicing, Assembly and Manufacturing (ISAM)
- Quantum Technologies
- End-to-End digitization and connectivity of engineering models
- Fully Integrated Earth Information System (EIS)



Distributed Systems Missions



Enceladus
Orbiter



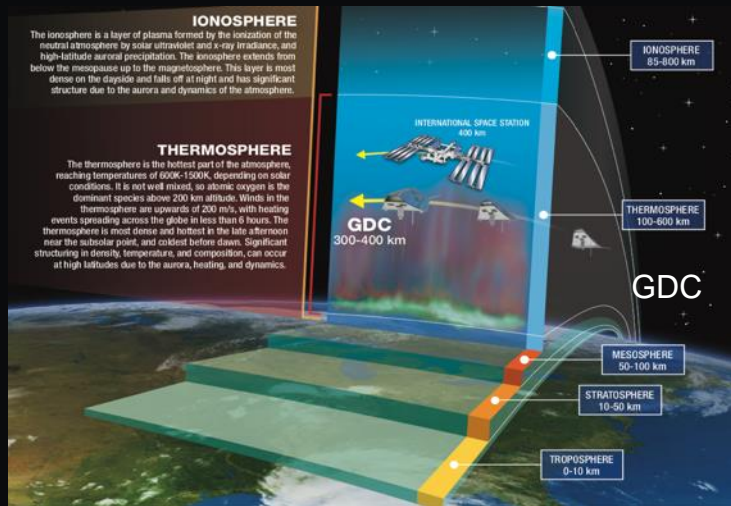
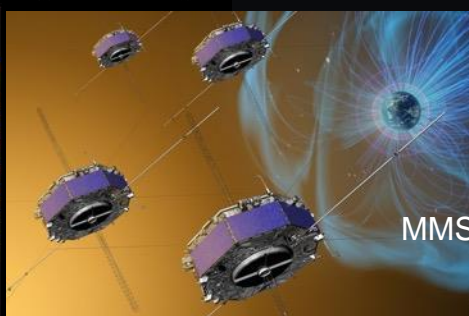
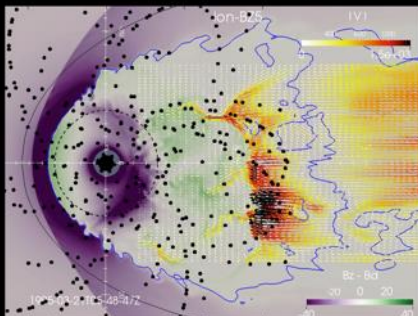
Science Drivers- Targeted Reference Missions

Transformational Science Planetary DSM enables:
Global Coverage, High Cadence, and Opportunistic Science

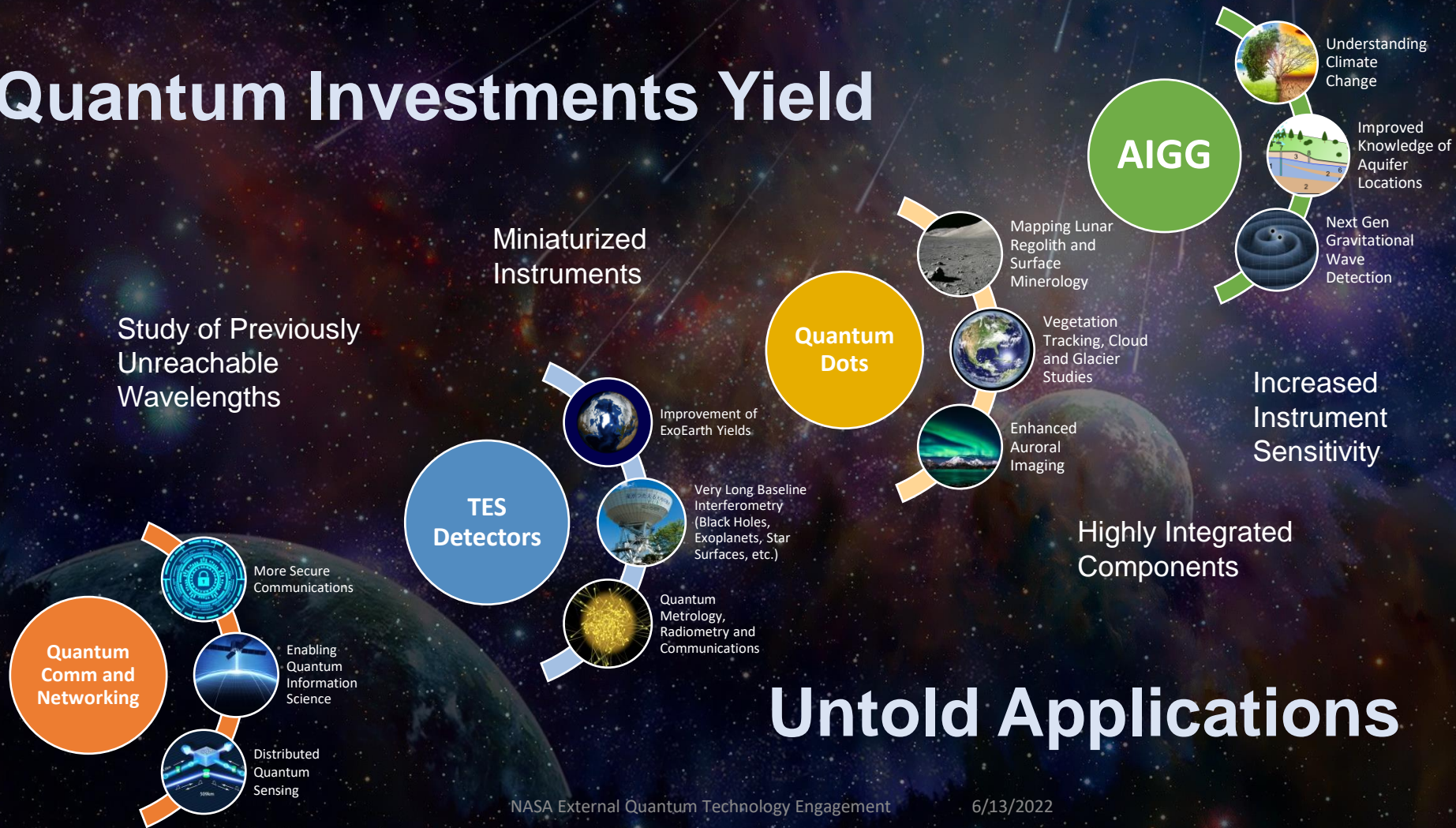
Identify novel events	More detailed measurements	Real-time response
Plume detection	Habitability and Biosignature Detection	Planetary and Space Weather
Volcanic eruptions	Active Tectonism	Opportunistic Science

MagCon+

DSM Enables Unprecedented Spatial and Temporal Coverage



Quantum Investments Yield



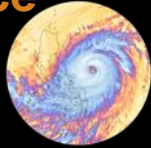
BREAKTHROUGH Earth Science

Impacting Society Through Transformative Earth Time-Variable Gravity Remote Sensing

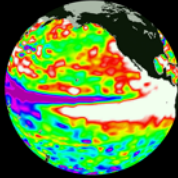


GRACE-FO / Science

- Sea level rise, and Ocean mass / heat transport budget



- Closure of global and regional water balance



- Dynamics of ice sheets and glaciers



AIGG Flagship / Societal Impacts

- Regional and local coastal vulnerability and risk assessment



- Regional and local monitoring and forecast of floods and droughts



- Regional and local water resource management



Increased accuracy and resolution of time-variable gravity data will transform the data's use from science to societal impacts.



The Future Vision of Goddard Engineering

- End-to-End digitization and connectivity of models that enables seamless flow and optimization through every phase of the mission
 - Instant understanding of science impact from changing engineering parameters
 - Virtual Reality to understand integration and test and in-space operations
 - Cradle to grave integrated models, from mission conception in the Integrated Design Center to final in-space mission operations

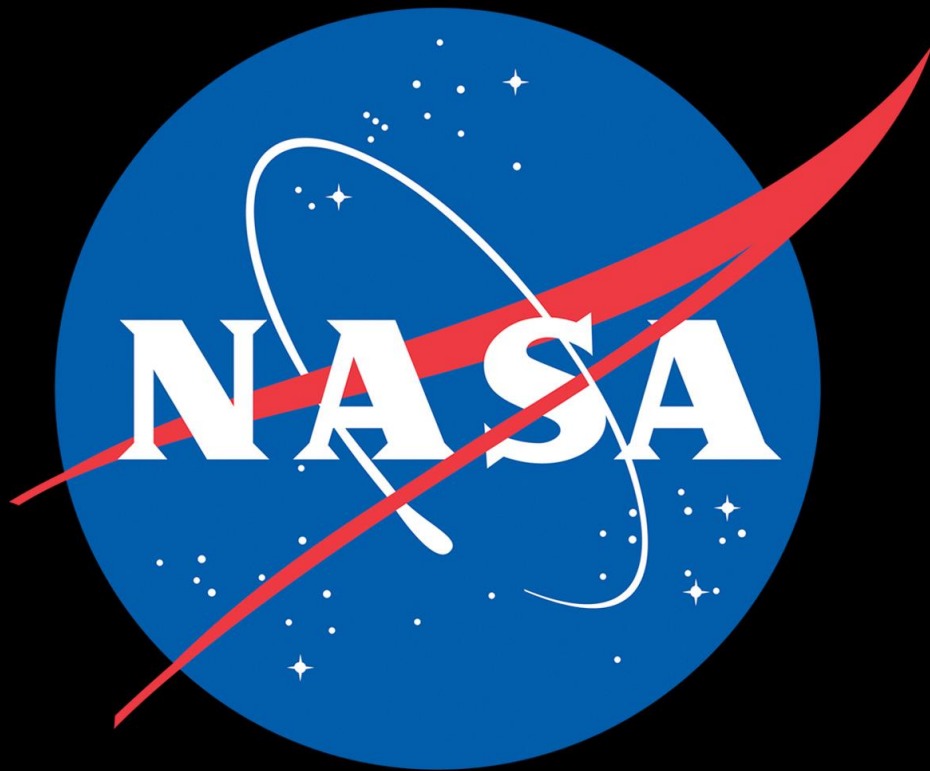


Evolved Structures: AI and robots enable **10x faster/cheaper** development of spaceflight structures

- Evolved Structures process
 - Design requirements are **digitally encoded**
 - Generative Design AI **evolves optimal structures**
 - Iterative design, analysis, and fabrication simulation
 - Digital Manufacturing robots **fabricate parts from CAD**
- Typical metallic structures – **now automated**
 - Requirements \rightarrow parts for fab in **1-2 days(!)**
 - Parts **$\sim 3x$ stiffer/lighter/stronger** than human designs
 - Demonstrated by **test**
- The Future
 - Make all structure development **10x faster/cheaper**
 - Trusses, flexures, lightweight optics

Designer	Expert Humans (2X)	AI
Design		
Design time	2 days	1 hour
Design iterations	4	31
Mass (kg)	0.27	0.2
1 st Mode (Hz)	65	147
Max Stress (MPa)	103	14.8
Manufacturing	CNC - Difficult to machine (no quotes)	Automated CNC \$1000 3 days
		18





For more information, please visit our web site:
www.nasa.gov/goddard