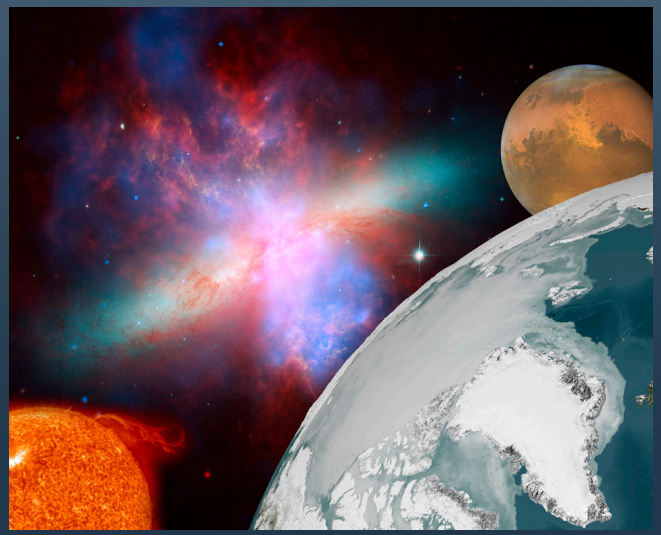
Welcome to the Sciences and Exploration Directorate!

Dr. Colleen Hartman
Director, Sciences and Exploration Directorate



Goddard Space Flight Center

Agenda

Who we are

What we do

How we do it

Why we do it

Goddard Space Flight Center

Quick Facts About SED

- Largest Earth and Space Science Research organization in the world
- Located in Greenbelt, New York and Wallops Flight Facility with 2640 people:
  - 543 Civil servants including ~400 Scientists
  - ~600 Co-located Post-Docs and University Scientists
  - ~1,500 Support Contractors, Visitors, Students, Emeritus, and other staff

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Goddard Space Flight Center's Sciences and Exploration Directorate members have received worldwide accolades for their work.

Dr. Piers Sellers

Most Excellent
Order of the British Empire
2011
Honors for services to science.

Dr. John Mather

Nobel Prize in Physics
2006
Rumford Prize 1996 Franklin Medal 1999

Dr. Mather is the recipient of more than 30 honors in the physical sciences.

Dr. Compton Tucker

Galathea Medal - Denmark 2004
Vega Medal - Sweden 2014
in Physical Geography

The Intergovernmental Panel on Climate Change (IPCC) was awarded the Nobel Peace Prize in 2007 for its work on climate change, together with former US Vice-President Al Gore.
Over 50 scientists from the Goddard Space Flight Center contributed to the IPCC Assessments that formed the basis for the award.

ipcc
INTERGOVERNMENTAL PANEL ON climate change

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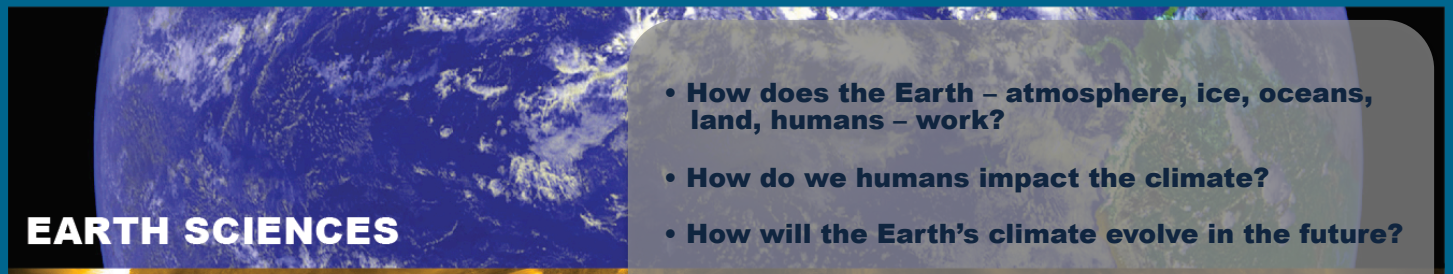
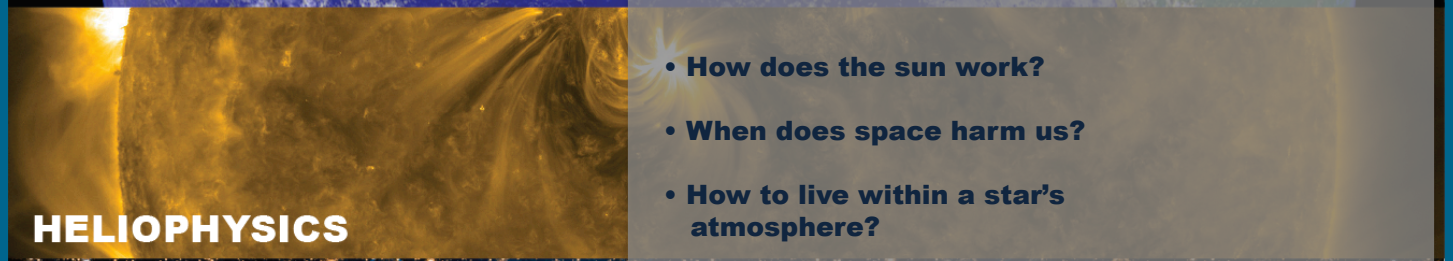
Goddard Begins and Ends with Science



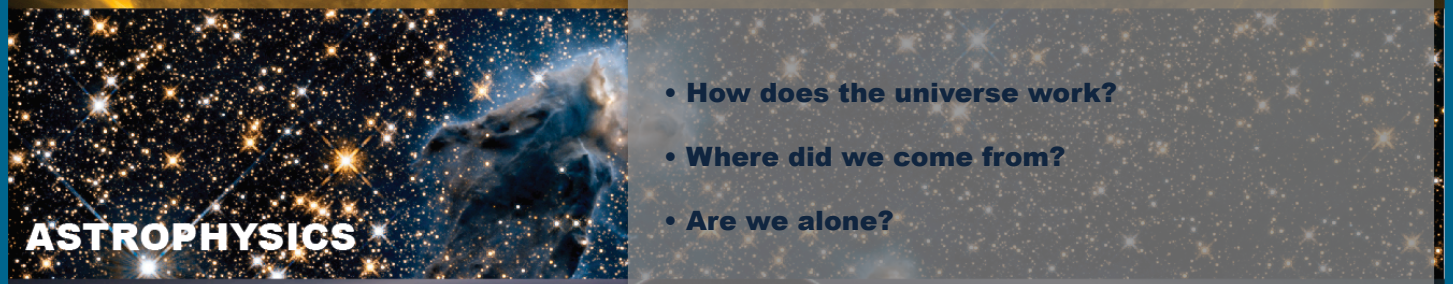
EARTH SCIENCES

- How does the Earth – atmosphere, ice, oceans, land, humans – work?
- How do we humans impact the climate?
- How will the Earth's climate evolve in the future?



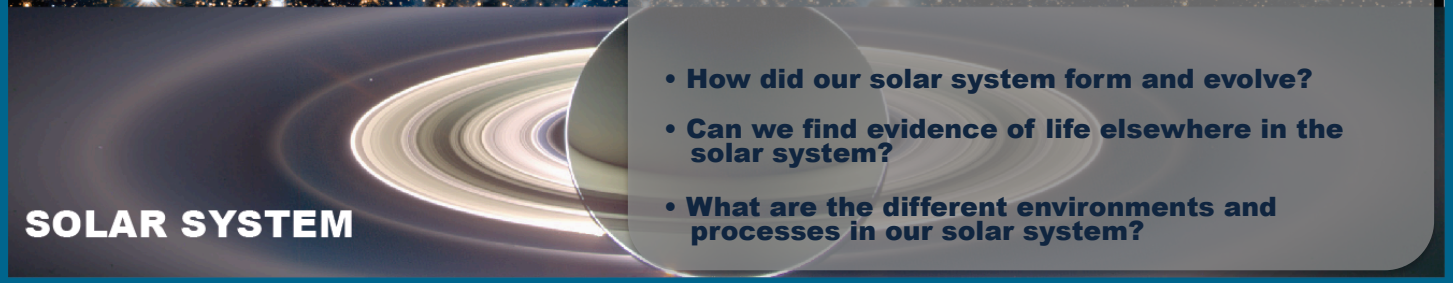
HELIOPHYSICS

- How does the sun work?
- When does space harm us?
- How to live within a star's atmosphere?



ASTROPHYSICS

- How does the universe work?
- Where did we come from?
- Are we alone?



SOLAR SYSTEM

- How did our solar system form and evolve?
- Can we find evidence of life elsewhere in the solar system?
- What are the different environments and processes in our solar system?

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Goddard Begins and Ends with Science

	Fundamental Questions	Current Missions	In Development	10 Year Horizon
HELIOPHYSICS	• How does the sun work? • When does space harm us? • How to live within a star's atmosphere?	ACE, AIM, ARTEMIS, CINDI Cluster, Geotail, Hinode, IBEX, IRIS, MMS, STEREO, SOHO, SDO, Rhessi, Themis, TIMED, TWINS, Van Allen Probes, Voyager, Wind, and over 20 sounding rocket missions	SET, GOLD, ICON Solar Probe +, Solar Orbiter STP5, Solar-C, SEE 2020 GEC	Solar Sentinels MagCon: ~2025 Other MIDEX and SMEX
EARTH SCIENCES	• How does the Earth – atmosphere, ice, oceans, land, humans – work? • How do we humans impact the climate? • How will the Earth's climate evolve in the future?	NOAA-19, Suomi-NPP, GOES-13, 14, & 15, DSCOVR, Landsat 7, 8, EOS-Terra, Aqua, Aura, GPM, SMAP, CATS (ISS)	NOAA - GOES-R, GOES-S, JPSS-1, JPSS-2 USGS - Landsat 9 ICESat-2, PACE Earth Venture - Instrument GEDI (ISS)	CarbonHunter, Lidar follow-on to ICESat-2, GEDI, USGS-Landsat 10 Cold atom gravimeter GPM follow-on; CAPM, PACE, NOAA – GOESS-R series NOAA – JPSS-3, 4
SOLAR SYSTEM	• How did our solar system form and evolve? • Can we find evidence of life elsewhere in the solar system? • What are the different environments and processes in our solar system?	MAVEN, Cassini LRO, SAM/Curiosity Juno,OSIRIS-REx, GEDI, Voyager	DAVINCI – Venus Atmosphere LUCY – Trojan Asteroid Survey Comet Nucleus-Sample Return Venus In Situ Explorer Trojan Tour and Lander Enceladus/Titan	Plume Life Detection Mars 2022 orbiter Mars Sample Return Korean Lunar Orbiter Volatile Resources Europa Lander
ASTROPHYSICS	• How does the universe work? • Where did we come from? • Are we alone?	HST, SWIFT, FERMI, XMM	TESS, JWST PIXIE, Litebird ETA, WFirst, NICER, TESS BETTII, AdEPT Other MIDEX and SMEX	LUVIOR FIR Flagship WFIRST ESA L3 MIDEX, SMEX

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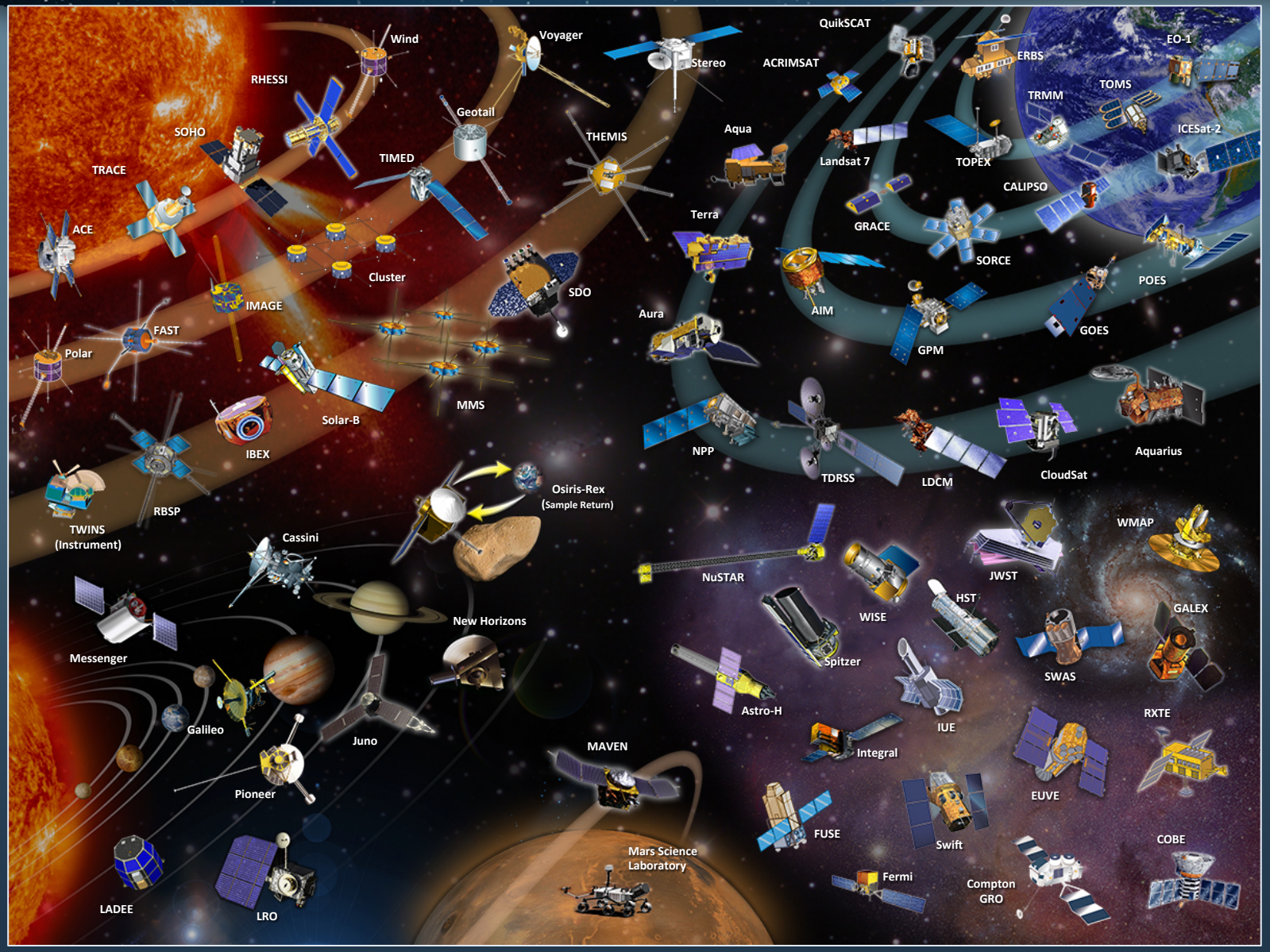
GSFC: A Diverse Mission Portfolio



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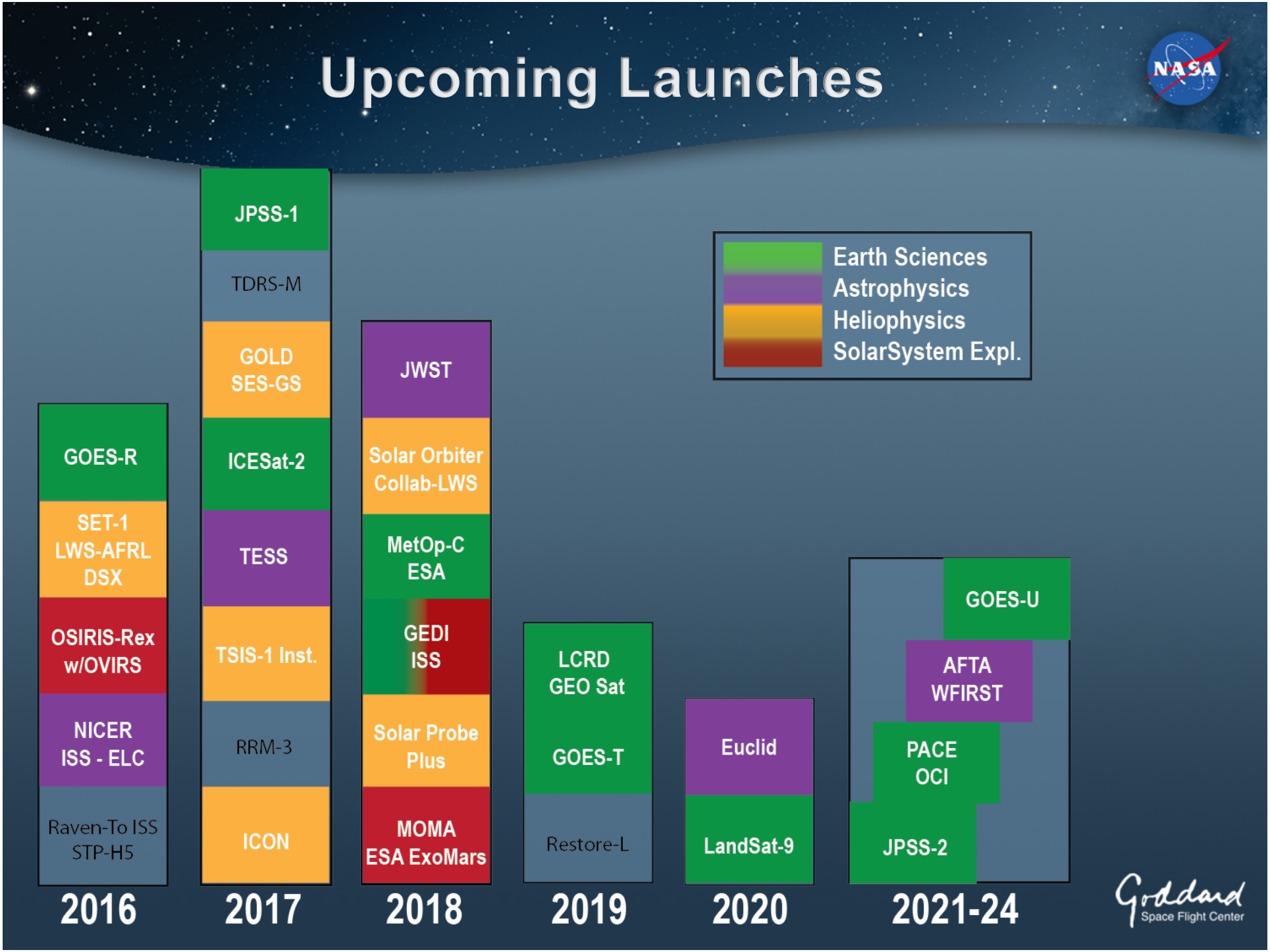
Upcoming Launches



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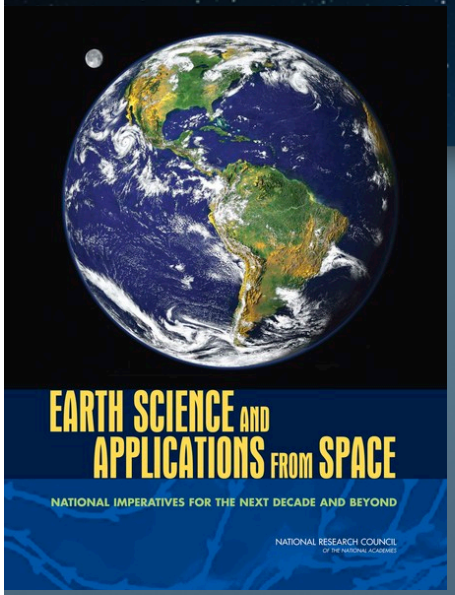
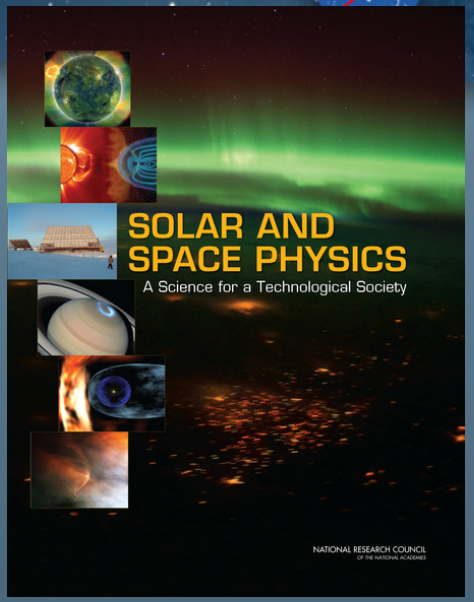
Decadal Surveys

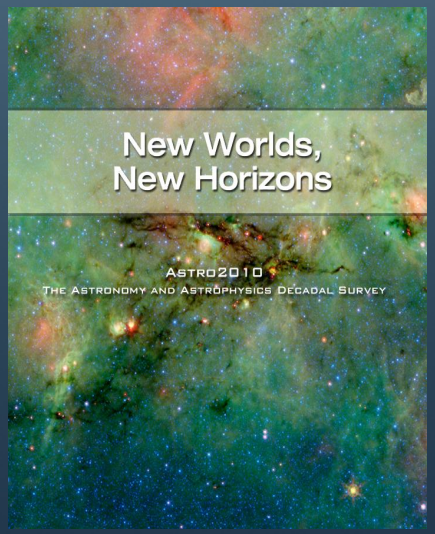


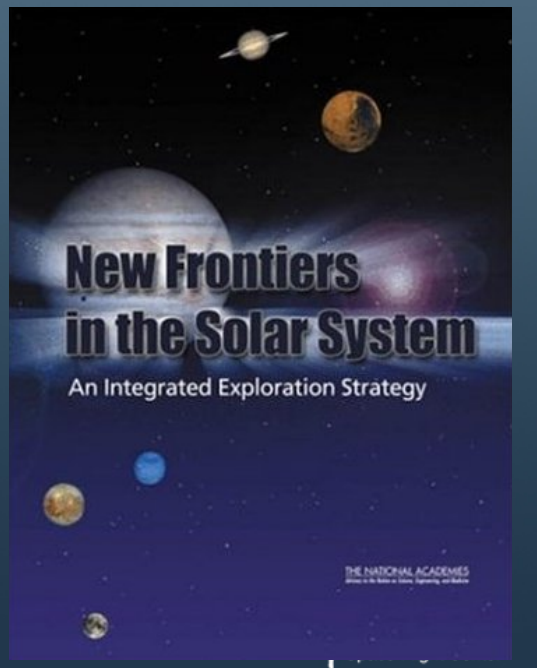
Strategic missions usually are >$1B and are prioritized by the NAS every 10 years through a Decadal Survey process engaging the entire community to reach a consensus on highest priorities

Smaller, more directed science missions are typically competed via AO's and are cost capped e.g. Explorer, Discovery, New Frontiers, Venture Class

GSFC partners with scientists at universities and other government labs to undertake these missions – we must be customer orientated!







Sciences and Exploration Directorate

SED provides scientific *leadership* and *stewardship* for space-based studies of the Earth, the Sun-Earth interaction, the Solar System, and the Universe through partnership with the scientific community to achieve NASA's science goals

- ***Project Scientists*** ensure that mission scientific goals are defined and realized, who participate in all aspects of the project management and oversight, and who represent the project to the science user community
- ***Principal Investigators*** conceive missions, instruments or investigations, assemble and lead teams to propose and implement the effort, and who are accountable for its success
- ***Scientific research and technology development*** in partnership with the engineering directorate and the scientific community enables future missions, make new discoveries, advance knowledge and benefit society
- ***Data modeling and science data centers*** maximizes the scientific return of hundreds of GSFC managed missions and instruments by providing freely accessible calibrated data, analysis software, and advanced modeling to the scientific community and the public
- ***Public Outreach*** widely communicates NASAs science program and inspire the next generation of scientists

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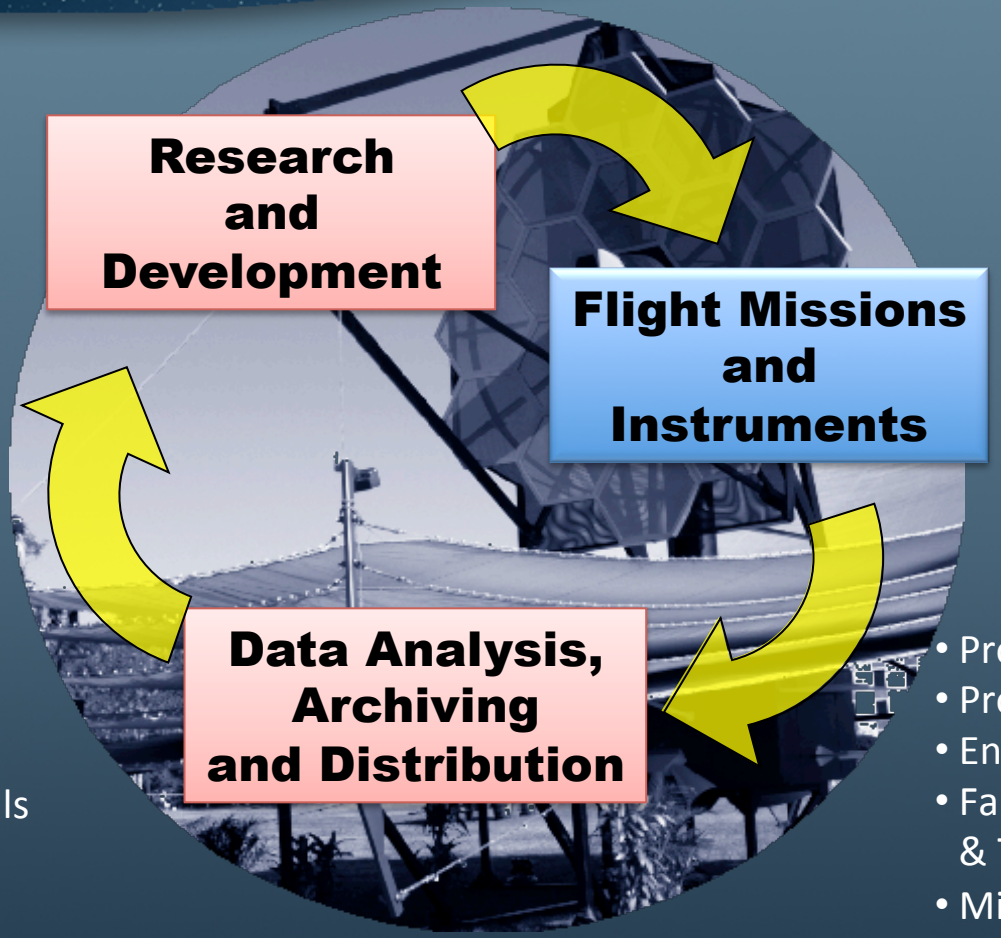
The Mission Cycle



- Lab experiments
- Technology Development
- Theory / Modeling
- Field Studies
- Concept Development

Flight Programs Leads

- Project Management
- Project Science
- Engineering
- Fabrication, Integration & Test
- Mission Design & Development
- Launch & Operations

SED Leads

- Observation Proposals
- Data Archives
- Applications
- Long-Term Modeling
- Data Products

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Funding of Research at NASA

- GSFC science research is driven by community peer review in a full and open competition with goals set by Decadal Surveys
- NASA scientists must write proposals as Principal Investigators and compete with the external science community for research funds, *including the funds that pay their salaries*
- There is also internal competition for center IRAD funds, as well as B&P to support proposal efforts
- Directed work is only related to project science and other service activities (equivalent to teaching at a University)

There is a lot of proposal writing in code 600!

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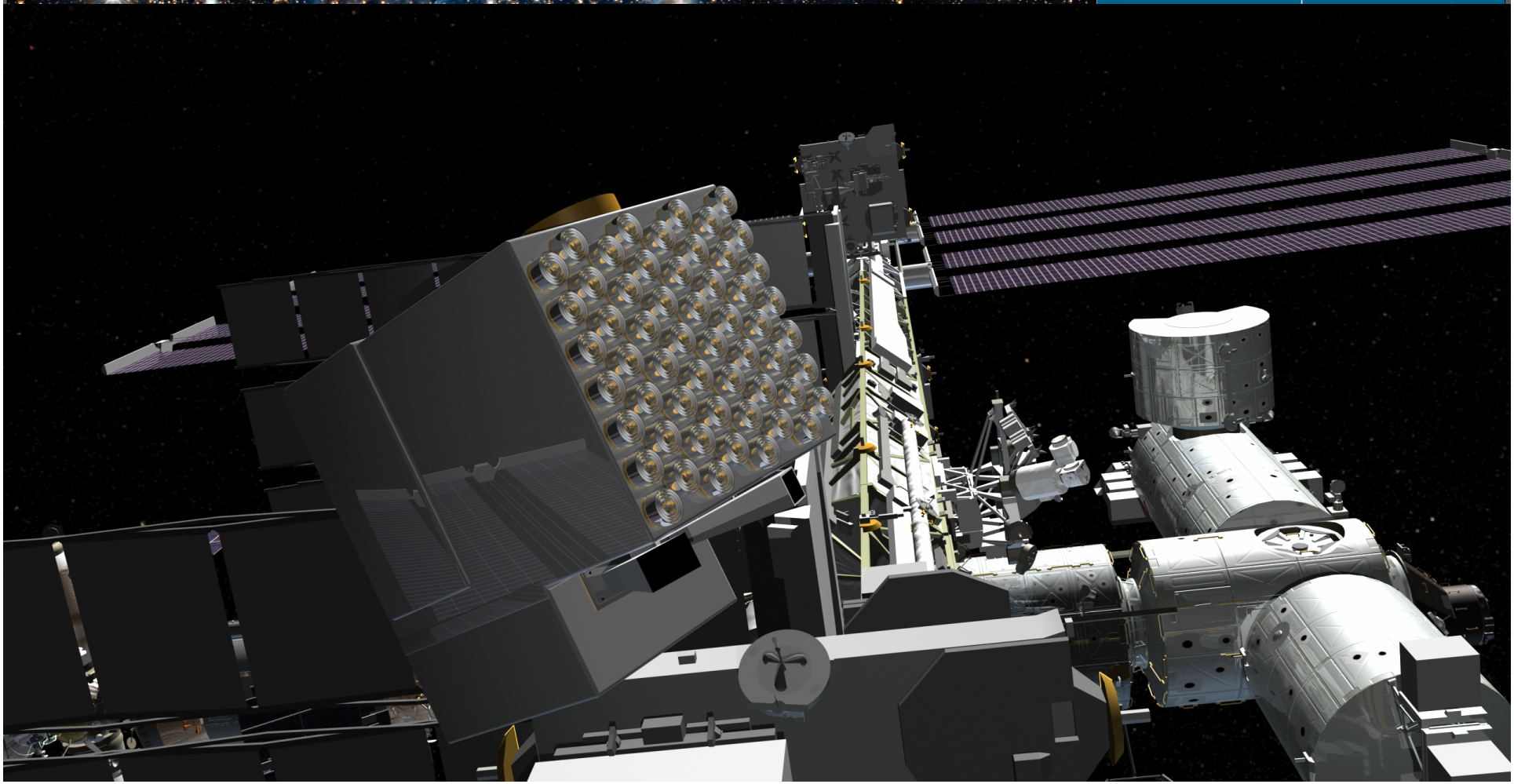
	Fundamental Questions	Current Missions	In Development	10 Year Horizon
ASTROPHYSICS	• How does the universe work? • Where did we come from? • Are we alone?	HST, SWIFT, FERMI, XMM	TESS, JWST PIXIE, Litebird ETA, WFirst, NICER, TESS BETTII, AdEPT Other MIDEX and SMEX	LUVIOR FIR Flagship WFIRST ESA L3 MIDEX, SMEX



JWST mirrors delivered and Installed at GSFC

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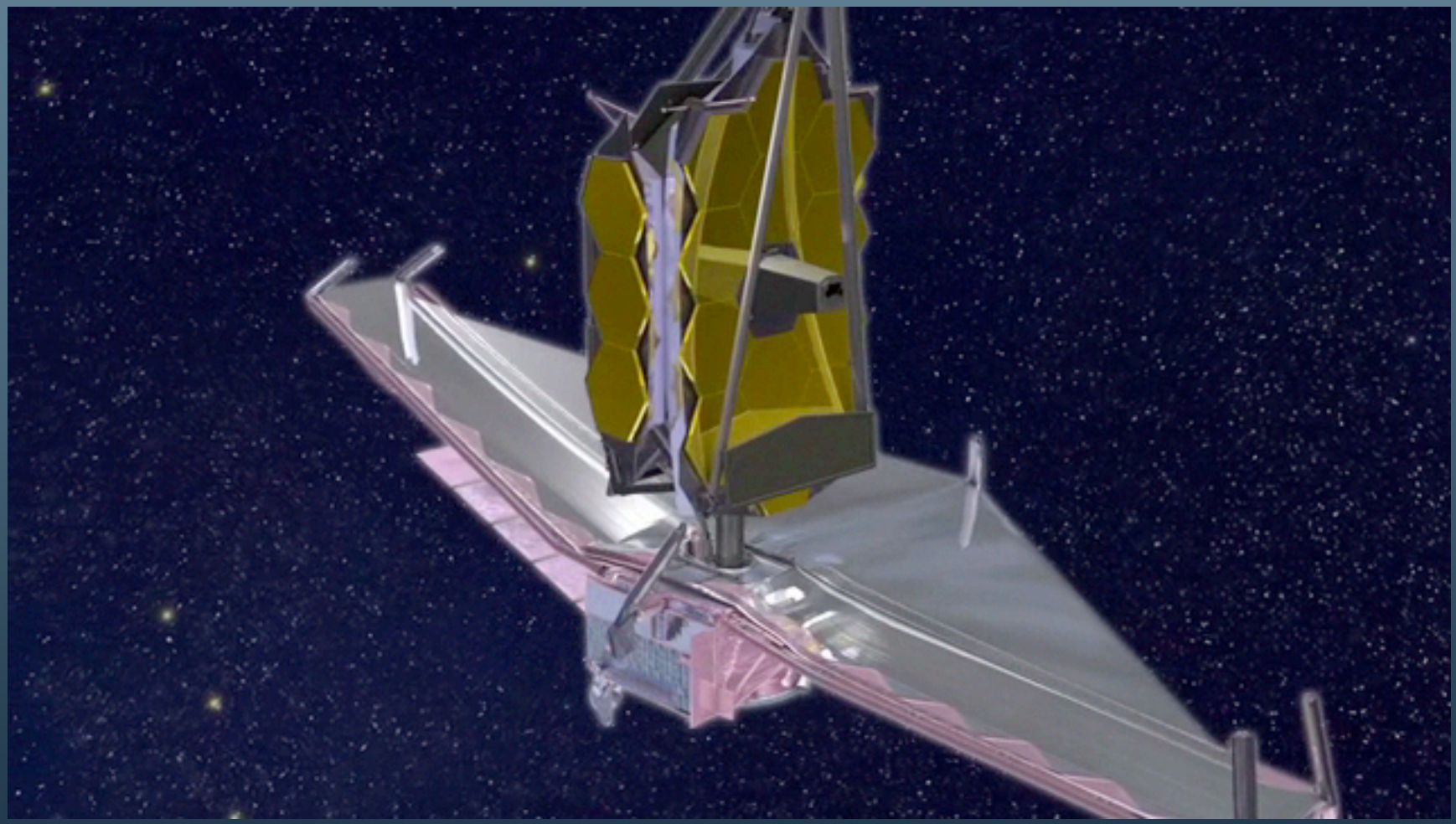
James Web Space Telescope Origami



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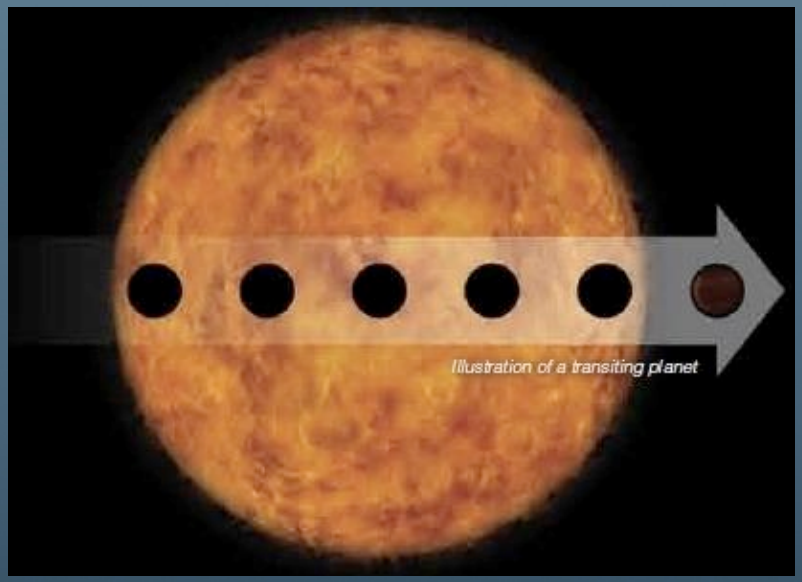
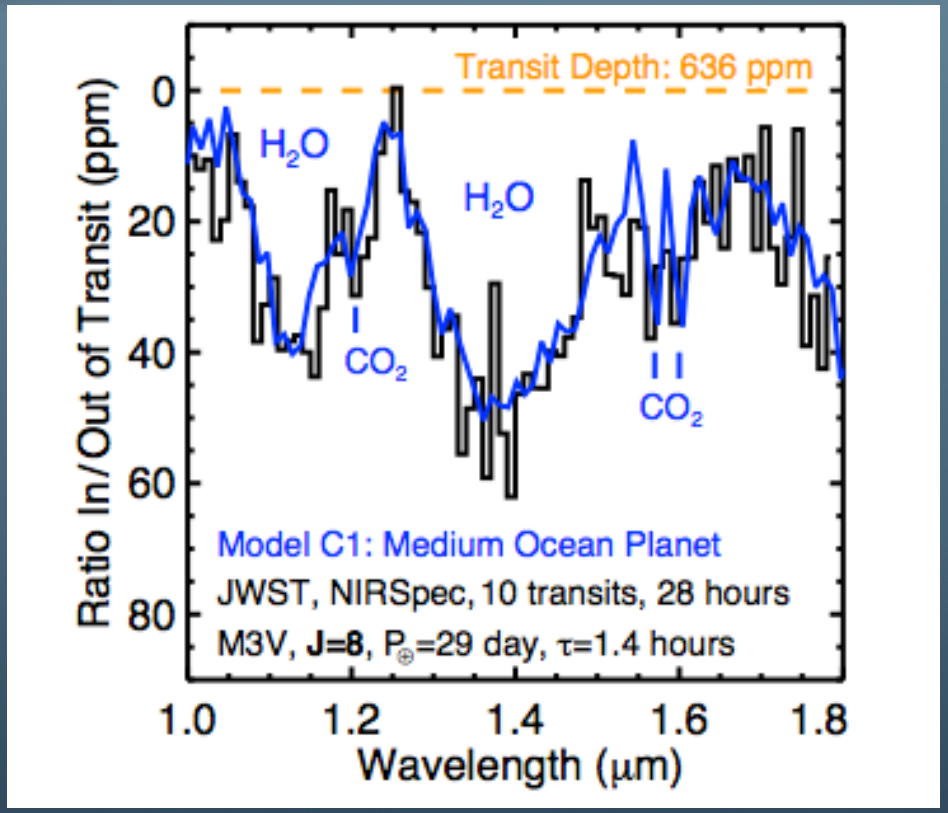
JWST Exoplanet Studies

JWST Science Themes – The Origins of Life





Simulated JWST observations of an Ocean planet half the mass of the Earth orbiting an M3V star

Water and CO_2 features are detectable in the NIRSpec instrument

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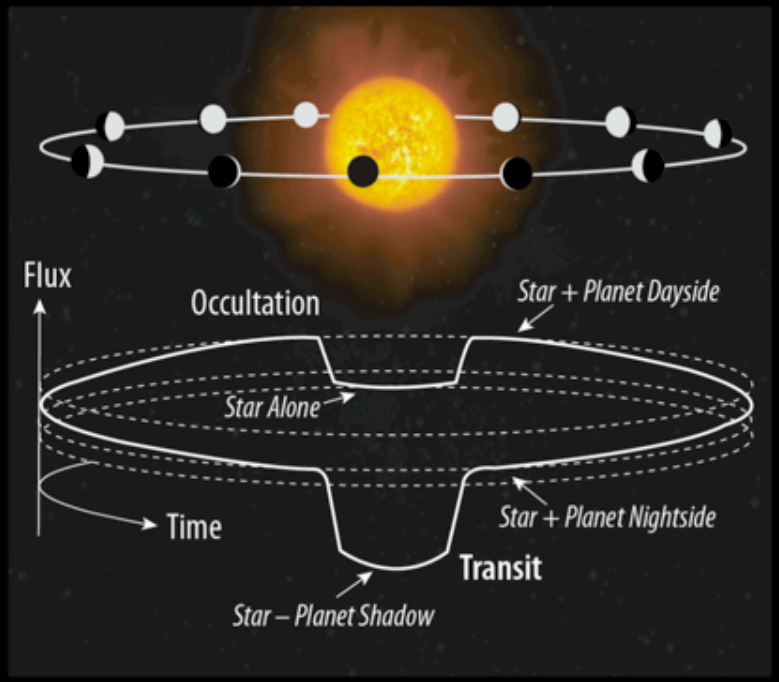
TESS Science Goals and Drivers

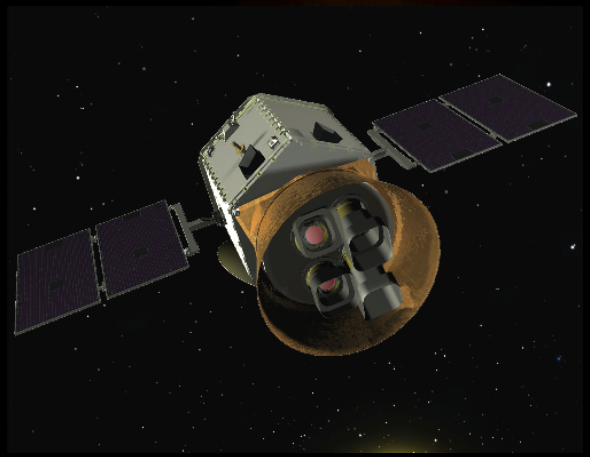
PI George Ricker MIT



Discover Transiting Earths and SuperEarths orbiting Bright, Nearby Stars

- Rocky planets
- Water worlds
- Habitable zone planets

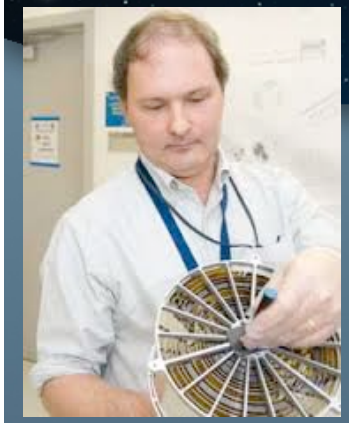
Discover the "Best" ~1000 Small Exoplanets



All Sky Survey of Bright Stars

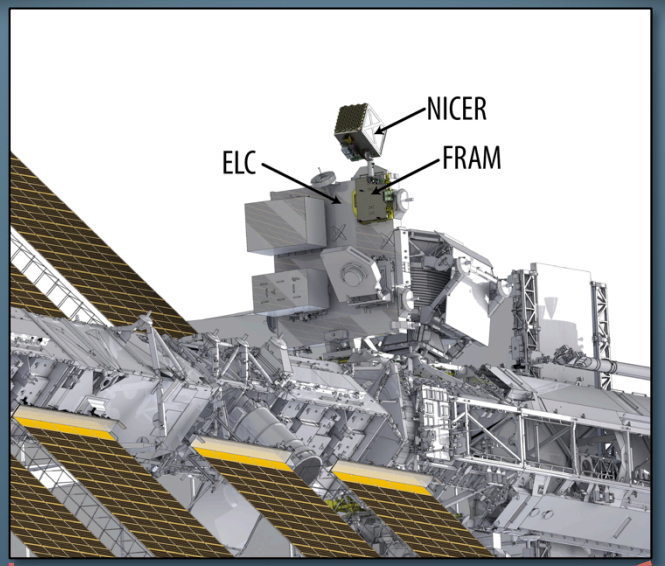
- F, G, K dwarfs: 4 to 12 magnitude
- M dwarfs known within ~60 pc
- 500,000 stars in two years

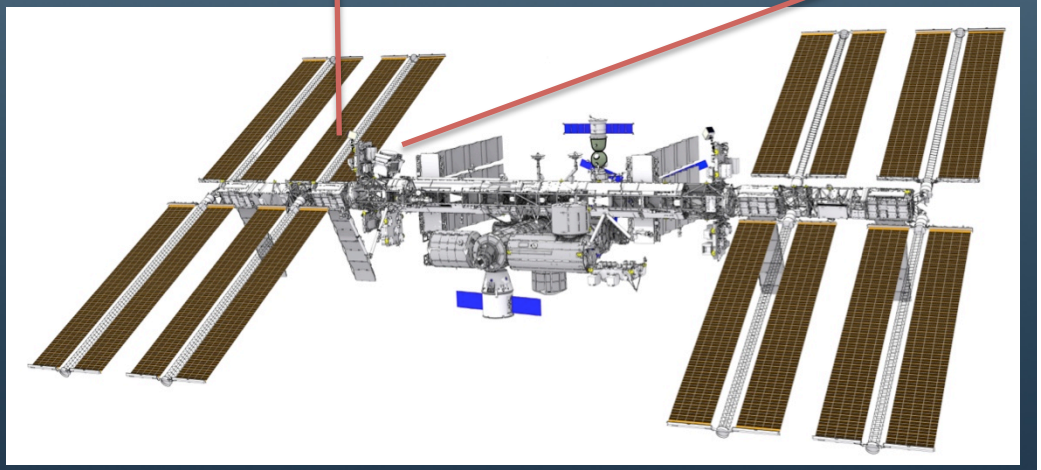
Neutron star Interior Composion ExploreR



PI: Keith Gendreau

- ***Science:*** Neutron stars
- ***Launch***: Late 2016
- ***Instrument:*** X-ray (0.2–12 keV) "concentrator" optics and silicon-drift detectors with 300 ns time tagging
- Demonstration of pulsar-based navigation





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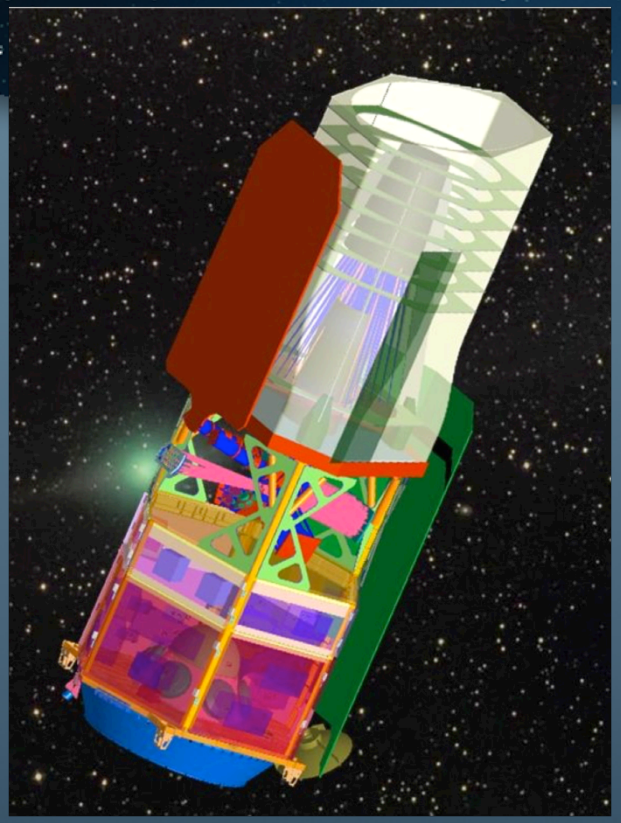
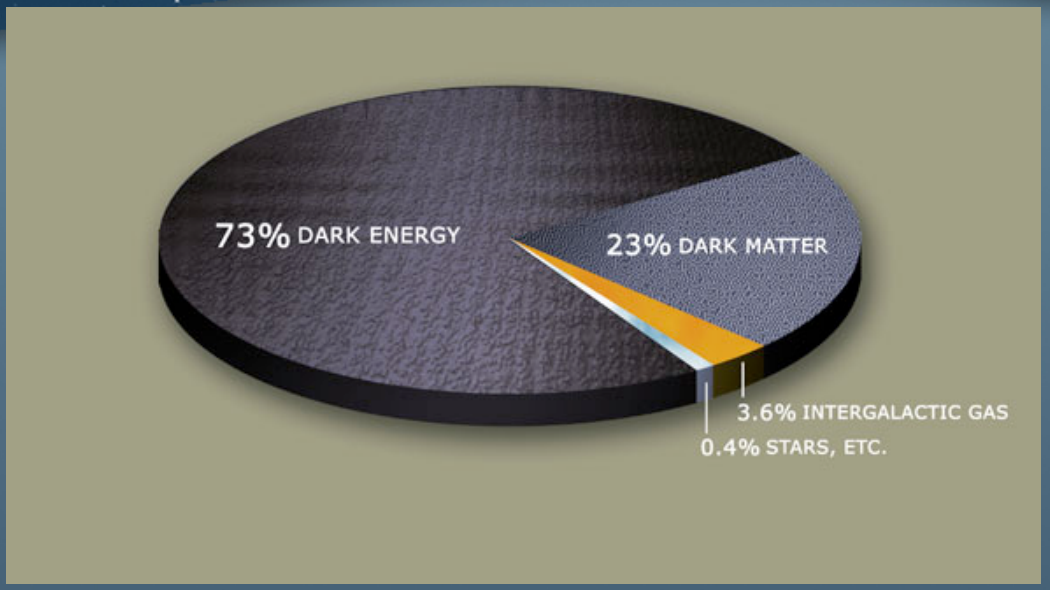
WFIRST – Dark Energy and Exoplanets





Wide Field Infra-Red Survey Telescope – WFIRST

Large scale surveys of the sky in the infra-red

Precisely measure the expansion and geometry of the Universe to study Dark Energy

Search for Extra-solar planets

Different implementation options being studied for launch in ~2023

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EARTH SCIENCES

Fundamental Questions

- How does the Earth – atmosphere, ice, oceans, land, humans – work?
- How do we humans impact the climate?
- How will the Earth's climate evolve in the future?

Current Missions

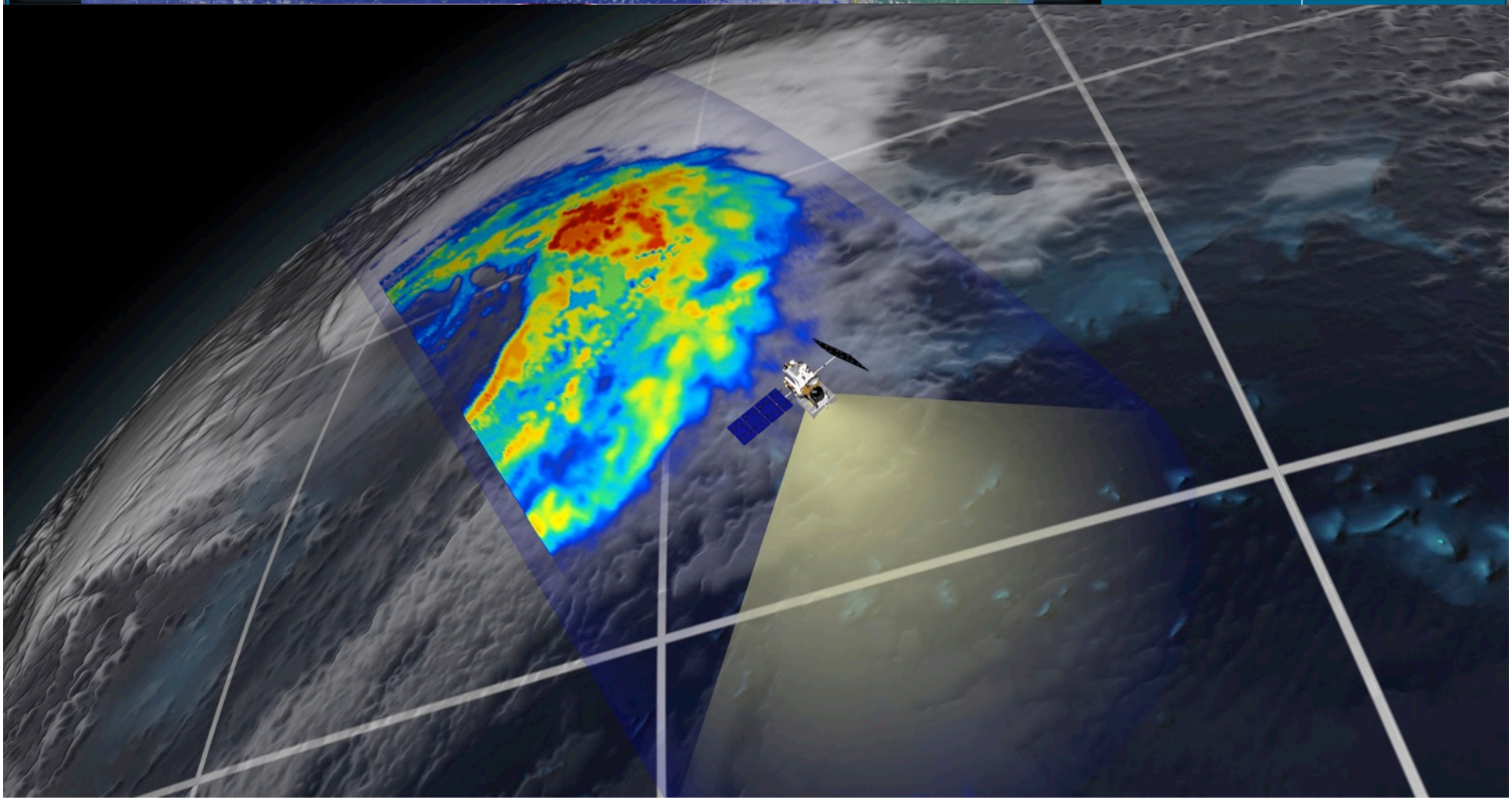
NOAA-19, Suomi-NPP, GOES-13, 14, & 15, DSCOVR, Landsat 7, 8, EOS-Terra, Aqua, Aura, GPM, SMAP, CATS (ISS)

In Development

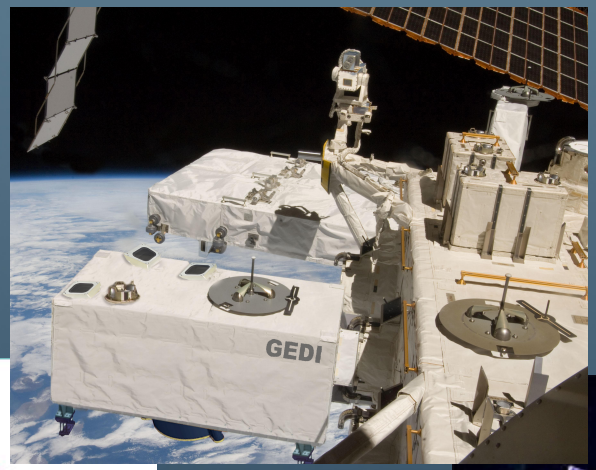
NOAA - GOES-R, GOES-S, JPSS-1, JPSS-2
USGS - Landsat 9
ICESat-2, PACE
Earth Venture - Instrument
GEDI (ISS)

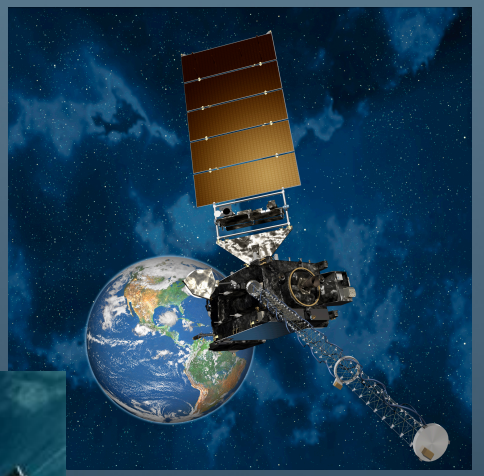
10 Year Horizon

CarbonHunter, Lidar follow-on to ICESat-2, GEDI, USGS-Landsat 10
Cold atom gravimeter GPM follow-on; CAPM, PACE, NOAA – GOESS-R series
NOAA – JPSS-3, 4



PACE GEDI ICESAT-2 GOES-R





PACE

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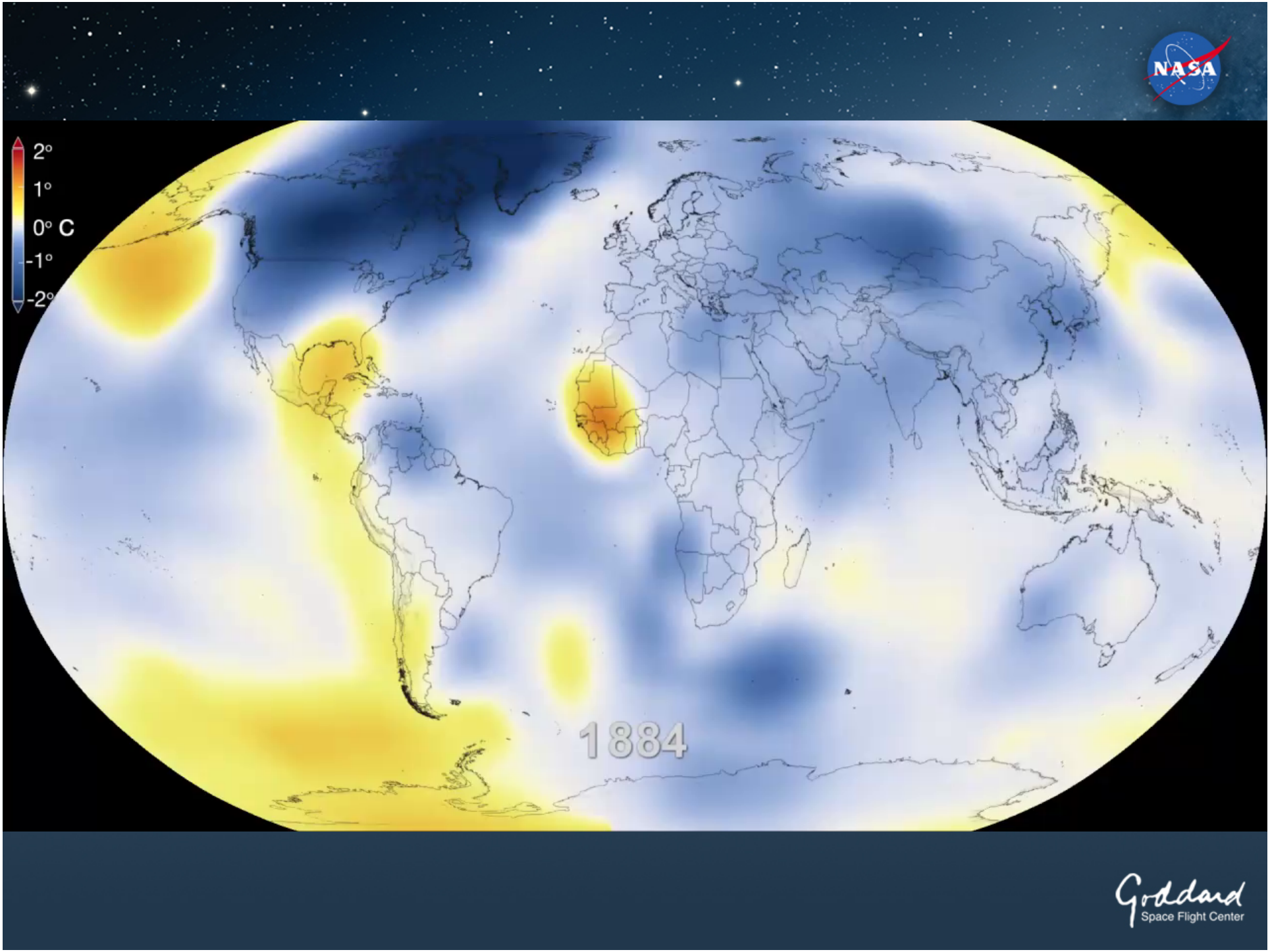
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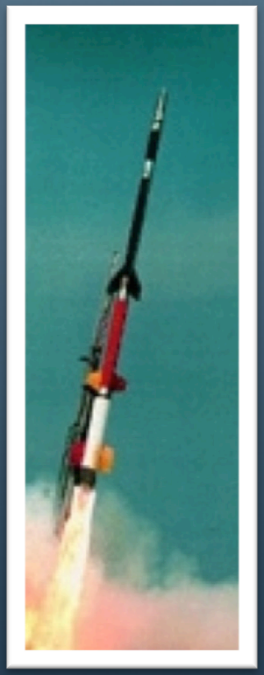
1884
NASA
Goddard
Space Flight Center

Sub-orbital & Aircraft Research Programs

Aircraft, Balloon & sounding Rocket Programs provide important research, excellent science, training experience, and pre-spaceflight demonstration of instrumentation



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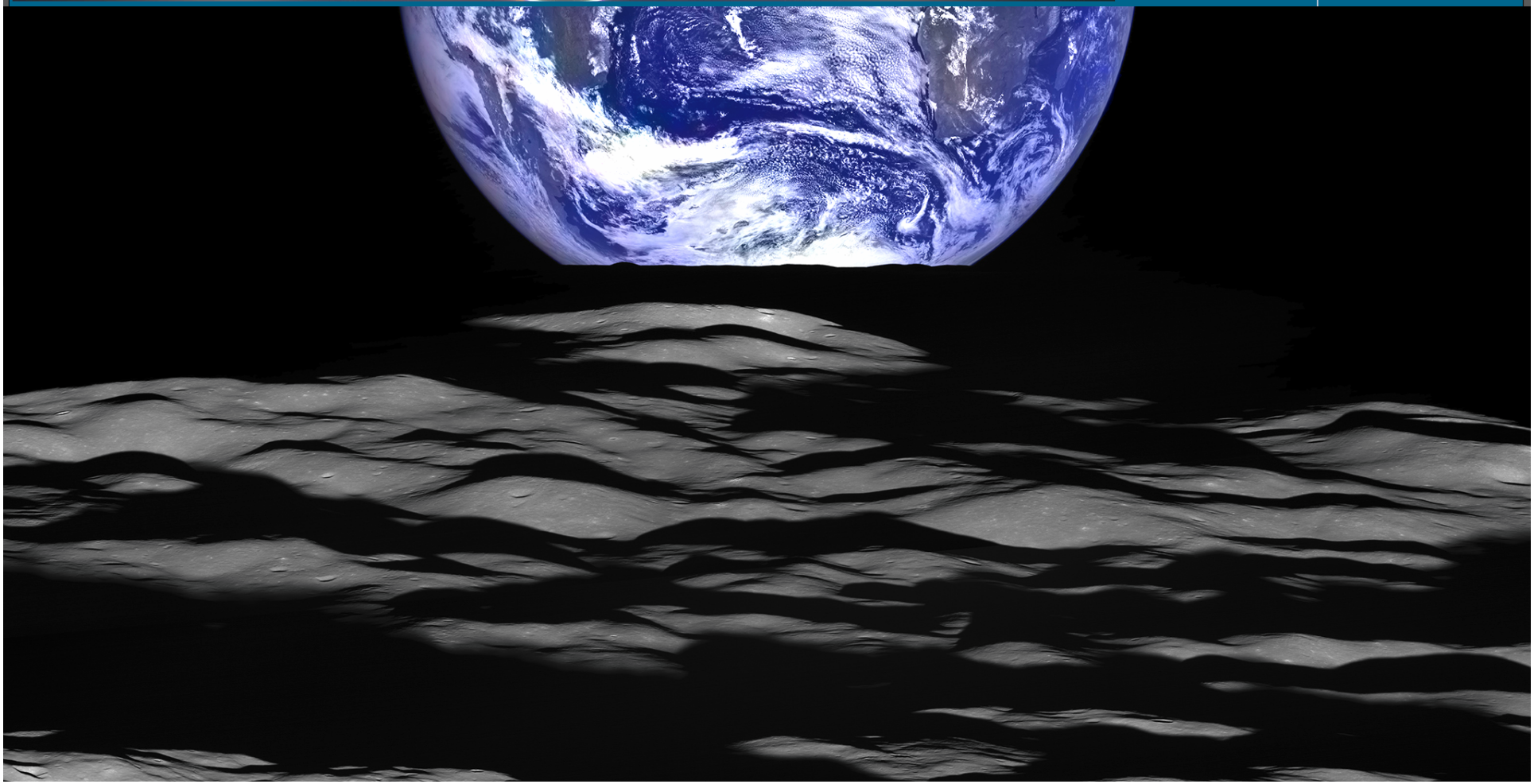
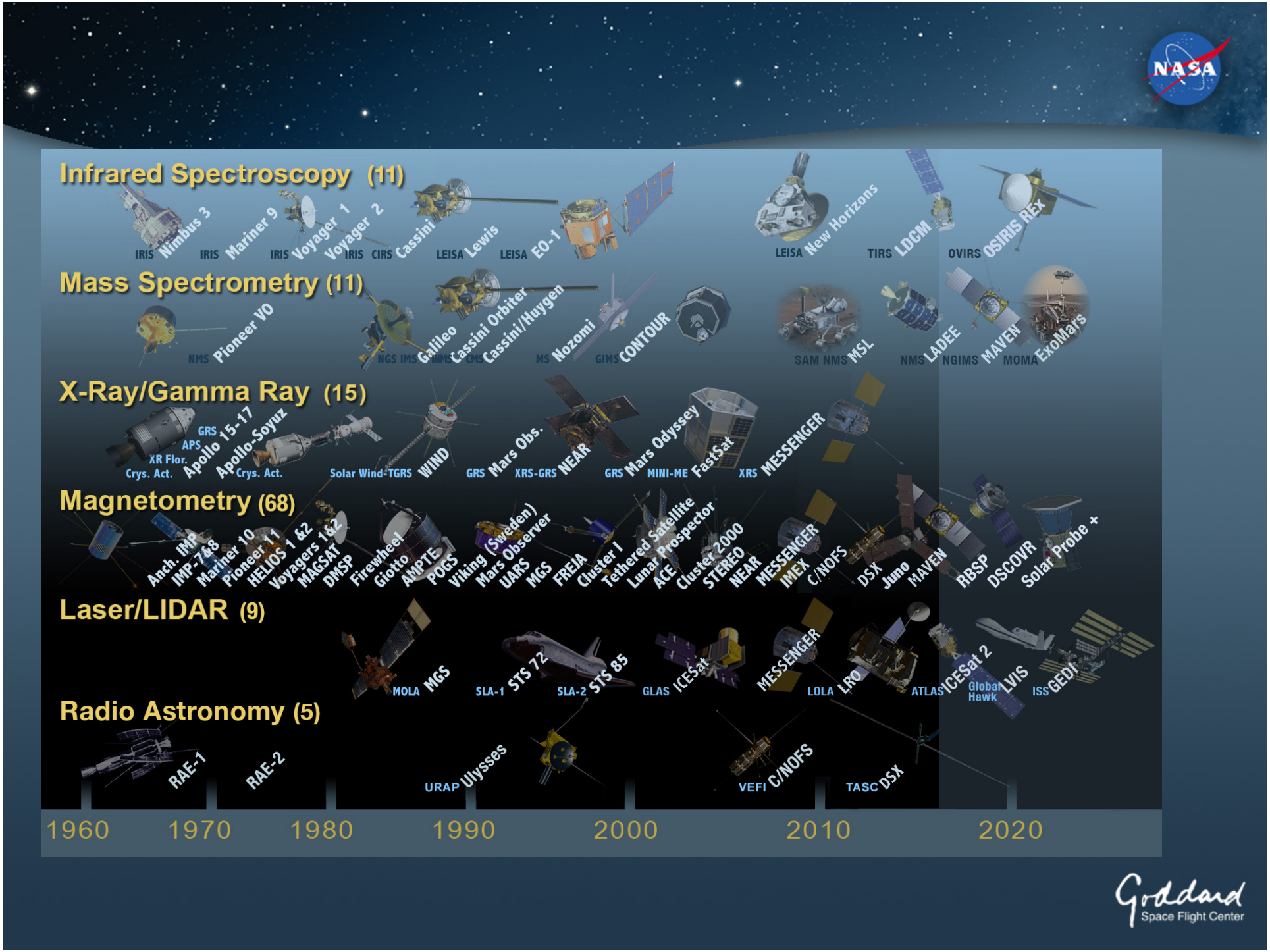
Solar System Exploration

Fundamental Questions	Current Missions	In Development	10 Year Horizon
• How did our solar system form and evolve? • Can we find evidence of life elsewhere in the solar system? • What are the different environments and processes in our solar system?	MAVEN, Cassini LRO, SAM/Curiosity Juno,OSIRIS-REx, GEDI, Voyager	DAVINCI – Venus Atmosphere LUCY – Trojan Asteroid Survey Comet Nucleus- Sample Return Venus In Situ Explorer Trojan Tour and Lander Enceladus/Titan	Plume Life Detection Mars 2022 orbiter Mars Sample Return Korean Lunar Orbiter Volatile Resources Europa Lander





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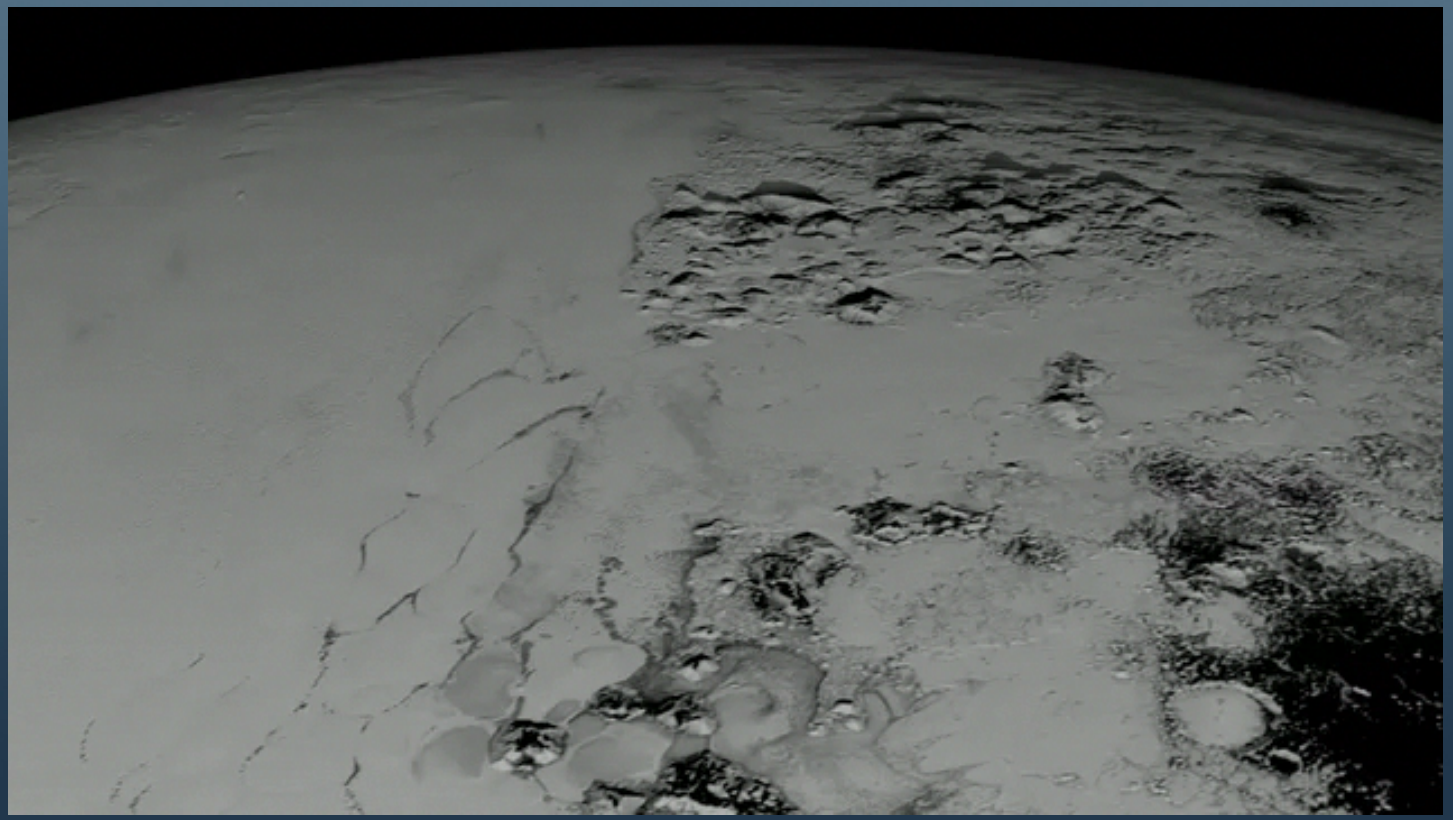
Pluto



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HELIOPHYSICS

Fundamental Questions

- How does the sun work?
- When does space harm us?
- How to live within a star's atmosphere?

Current Missions

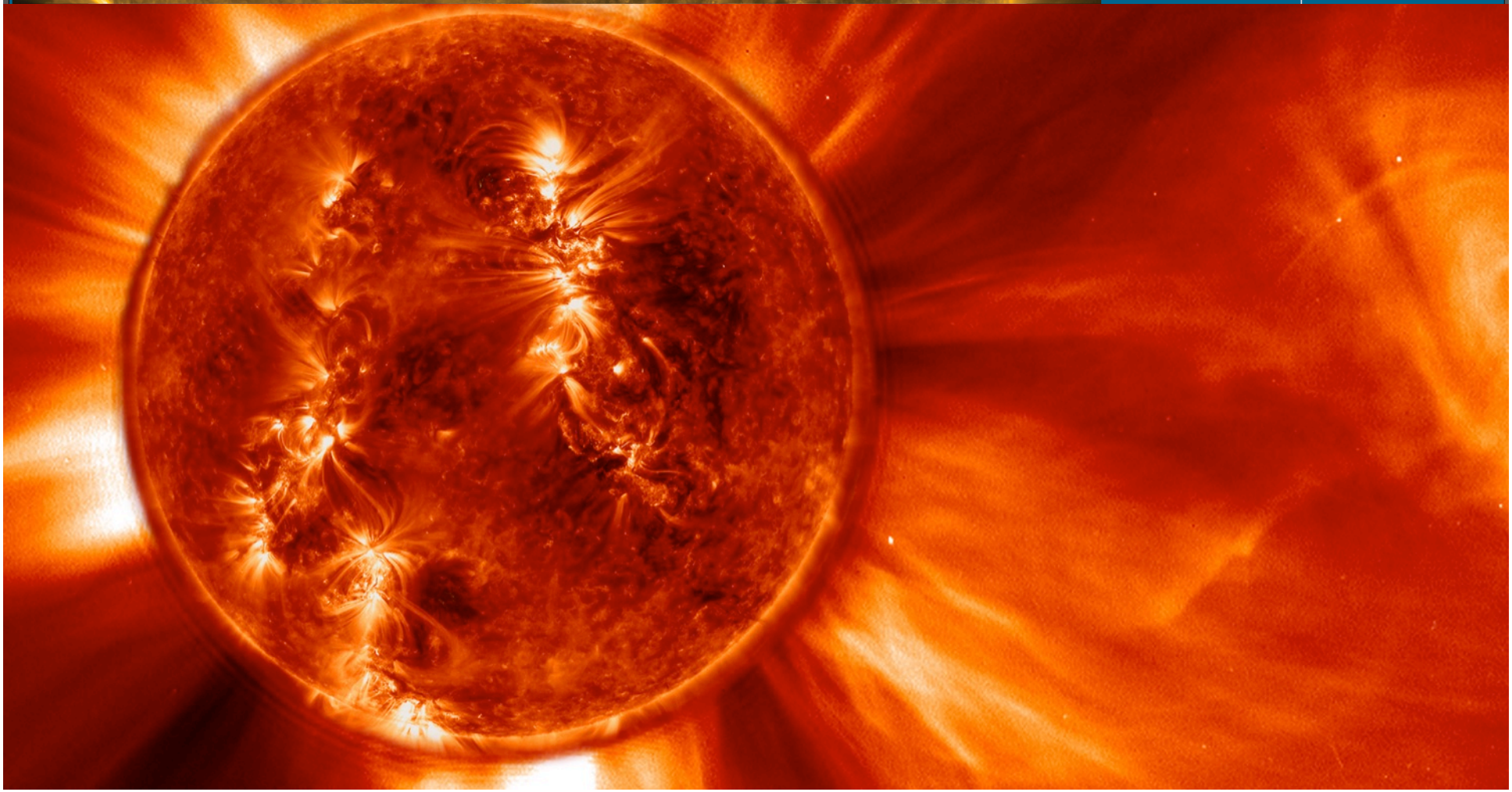
ACE, AIM, ARTEMIS, CINDI
Cluster, Geotail, Hinode,
IBEX, IRIS, MMS, STEREO,
SOHO, SDO, Rhessi, Themis,
TIMED, TWINS,
Van Allen Probes,
Voyager, Wind, and
over 20 sounding
rocket missions

In Development

SET, GOLD, ICON
Solar Probe +,
Solar Orbiter
STP5, Solar-C, SEE
2020
GEC

10 Year Horizon

Solar Sentinels
MagCon: ~2025
Other MIDEX
and SMEX



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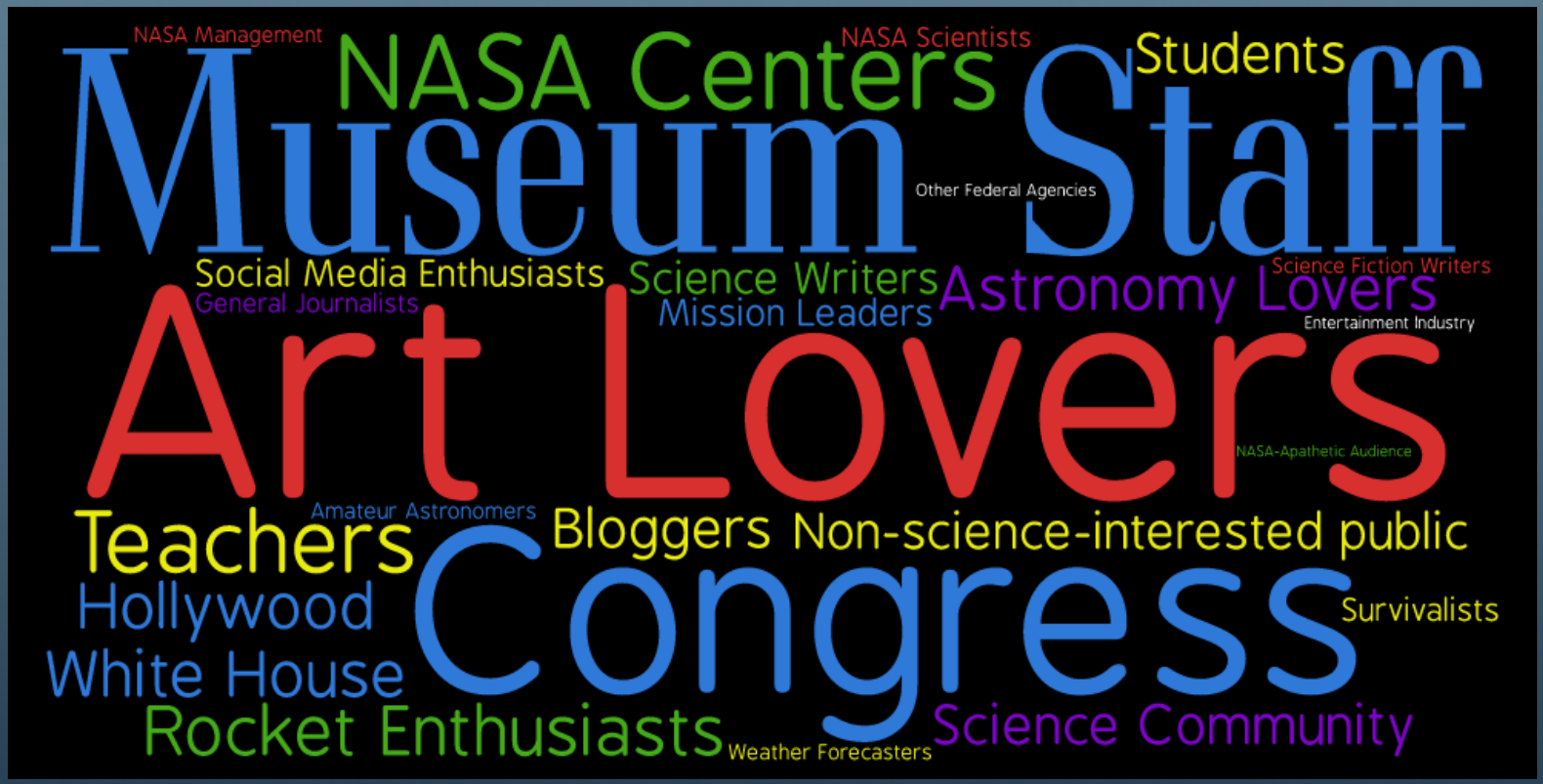
Outreach: Know your Audience



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Outreach: Know your Goals

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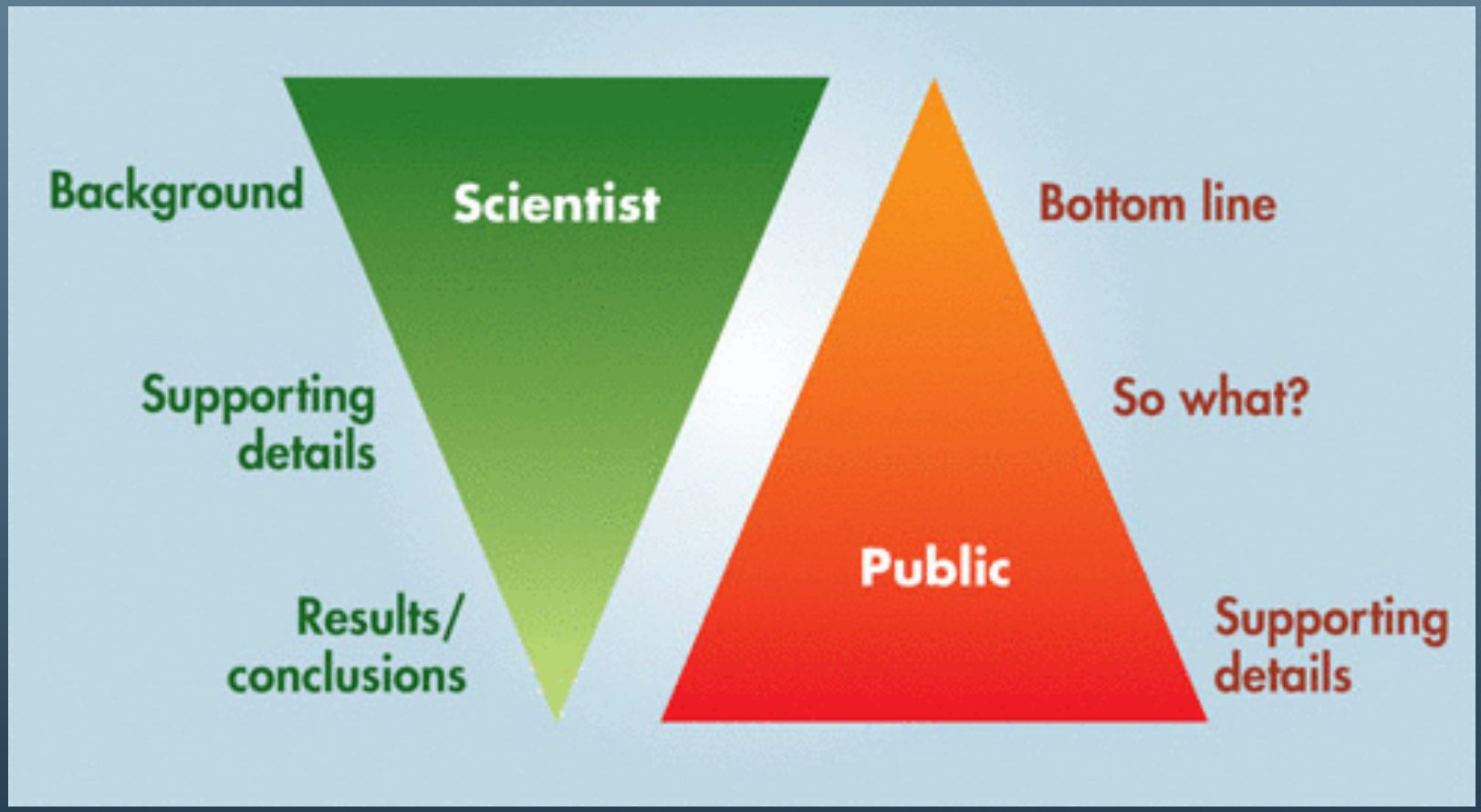
Get to the Point



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