National Aeronautics and Space Administration

THE CRITICAL PATH

A FLIGHT PROJECTS DIRECTORATE PUBLICATION ■ 2024 FALL ISSUE

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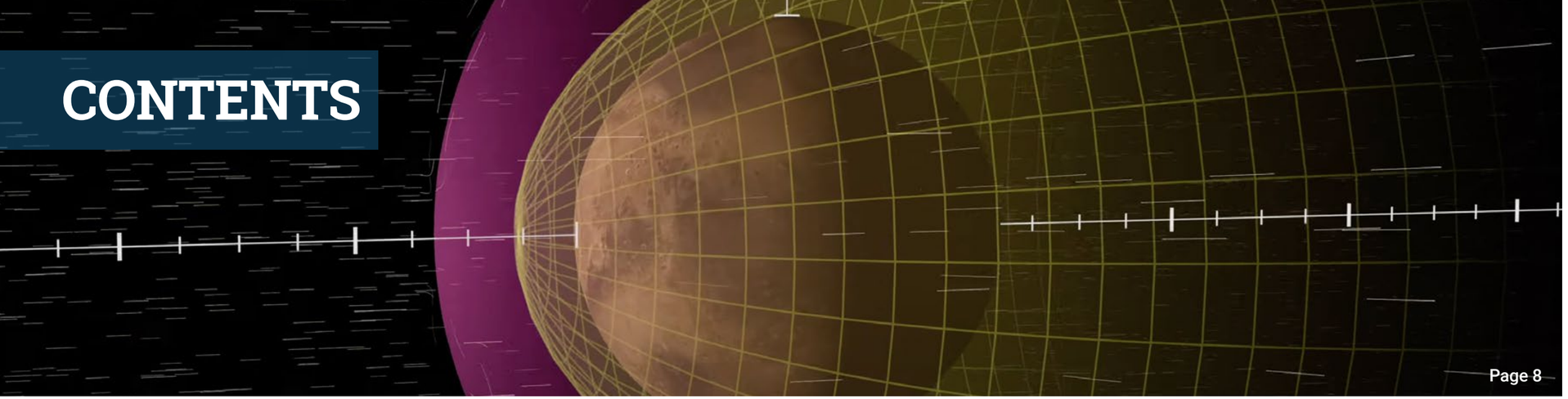
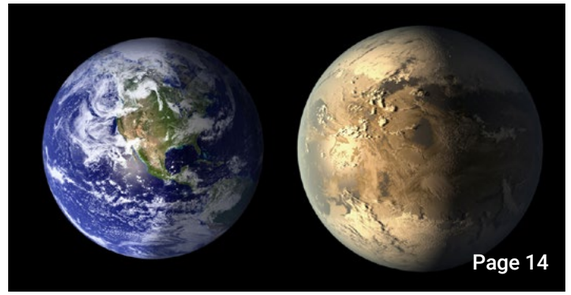
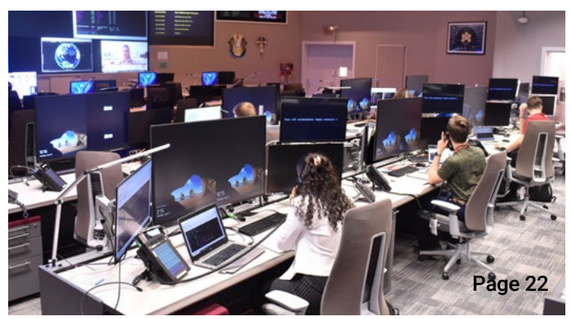


COVER IMAGE: This top-down view shows NASA's Nancy Grace Roman Space Telescope's spacecraft bus, as it awaits instrument integration. The spacecraft bus is 13 feet (4 meters) wide by 6.5 feet (2 meters) tall and weighs in at 8,400 pounds (3,800 kilograms). In this photo, it rests atop an aluminum ring that will not be part of the observatory. The bundles of wires on top are part of more than 50 miles of cabling laced throughout the assembly to enable different parts of the observatory to communicate with each other. CREDIT: NASA/CHRIS GUNN

*MAVEN celebrates 10 years in orbit. Learn about the "disappearance" of the solar wind at Mars that was witnessed by MAVEN – an event last seen nearly a quarter-century ago at Earth. (**MAVEN screenshot from video around 1:14**)* CREDIT: NASA





THE CRITICAL PATH
A FLIGHT PROJECTS DIRECTORATE PUBLICATION | 2024 FALL ISSUE

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The deadline for the next issue is **March 17, 2025**

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Insights from the DIRECTOR

Cathy Richardson
Director, Flight Projects

Looking Ahead to 2025

As we prepare to enter 2025, the Flight Projects Directorate (FPD) is presented with an opportunity to renew and strengthen our organization. In the coming year, we plan to intentionally set aside time and provide resources to build ourselves as a more agile, future-ready team aligned with Goddard's 2040 vision. I know some of you may still be unsure of how this vision affects our organization. For FPD, we will continue to provide the exceptional project and program management that we are known for while taking deliberate steps to transform our organization to ensure we are equipped for any new challenges or opportunities that lie ahead to support the future of project management here at Goddard.

Over recent months and through the remainder of this year, FPD is focused on defining several key strategic activities. We look forward to sharing more about these initiatives during our January 2025 Town Hall, when we plan to introduce our 2025 strategic thrusts in greater detail. Some of our initial initiatives are focused on:

- **Streamlining Processes:** Continuing to refine and reduce requirements and burdens on our projects to enable smoother workflows and better align processes with individual risk profiles.
- **Standardized Reporting:** Establishing performance-based, common reporting methods—an effort that has already seen significant contributions from various divisions.
- **Training Enhancements:** We're further evolving training activities and considering options like Center-wide curriculums to provide comprehensive project management education.

These improvements would not be possible without the outstanding leadership from our supervisors and division and organizational managers who bring unique expertise to each initiative. We are also looking to our current team members and future leaders to embrace these changes and contribute to our optimism and vision going forward. We welcome and strongly encourage your individual input and ideas for innovative approaches to bring us into the future. Get involved in these activities in your individual organizations or provide feedback to FPD directly.

I would be remiss to end the year without also celebrating our successes from 2024. Our teams have achieved remarkable progress this past year, paving the way for further success in 2025. Highlights include:

- **Initiating the Habitable Worlds Technology Maturation Office:** In collaboration with the Science Exploration Directorate (SED), we implemented a new project infrastructure for the Habitable Worlds Technology Maturation Office, supporting Goddard 2040 Vector 2.
- **Launch Milestones:** We celebrated many significant achievements, some of which included the PACE and GOES-U launches—which marked significant scientific achievements and the culmination of the successful development of the GOES-R series. Goddard also supported the Europa Clipper launch as well as several launches from other institutions led by our Goddard-located program offices.
- **Program Success:** FPD teams are making substantial progress on our newer programs with NOAA, including Space Weather Next, GeoXO, and NEON, and the initial awards for our new Earth System Explorers Program.
- **Daily Successes:** Our teams continue to perform at the highest level every day, supporting critical mission life cycle reviews and new project opportunities. As examples, the Roman Space Telescope team successfully received all major system components at Goddard, the Earth science portfolio initiated two new project opportunities with SED, and many of our team members have experienced personal achievements and milestones.

I want to also acknowledge that we have experienced some impactful losses this year and many have struggled with great uncertainty. I hope we can join together to celebrate our accomplishments, offer our best wishes to those retiring, and remember the contributions of our dear colleagues who are no longer with us. As we approach the end of the calendar year, I encourage you to take time to relax with loved ones, recharge, and prepare for an exciting new year.

To close, I want to honor our teams and share my excitement for FPD's future. Entering 2025, I am committed to promoting an environment that supports personal growth, resilience, and success. Our management teams are here to provide the resources, tools, and support needed to thrive, both in your career and personally. With the foundation we've laid this year, I am optimistic about what we can accomplish together in 2025. Let's embrace the opportunity to make FPD an even stronger organization. Thank you all for your hard work, dedication, and resilience.

Cathy Richardson
Director, Flight Projects
cathleen.m.richardson@nasa.gov

Congratulations to Barbara Grofic, Code 440 Astrophysics Projects Division Associate Director and Physics of the Cosmos and Cosmic Origins Program Manager! Barb was awarded the 2024 Women in Tech "Best Ally" award for the North American Region and was a global finalist for the Global Award at the ceremony in Paris, France, held on November 14, where she competed against representatives from seven other regions. This award honors individuals who actively support and advocate for women in technology, highlighting their efforts in mentorship, creating inclusive environments, and promoting gender diversity within the tech community.

Learn more about the organization and the other categories and North American recipients at: **https://womenintech-awards.com/america/**as well as the Global Award recipients at: **https://womenintech-awards.com/2024-global-awards/**.

Rachel Bushey / Code 440
Astrophysics Projects Division Technical Writer

Latest from NASA's Nancy Grace Roman Space Telescope:

Instruments Arrive!

This photo shows the Wide Field Instrument arrives at the big clean room at NASA's Goddard Space Flight Center. About the size of a commercial refrigerator, this instrument will help astronomers explore the universe's evolution and the characteristics of worlds outside our solar system. Unlocking these cosmic mysteries and more will offer a better understanding of the nature of the universe and our place within it. CREDIT: NASA/CHRIS GUNN

The Nancy Grace Roman Space Telescope is a future NASA infrared observatory designed to explore essential questions in astrophysics, cosmology (the growth of structure and expansion history of the Universe), and exoplanets. As a survey mission, Roman will map thousands of degrees of the night sky over five years, tracking stars, galaxies, and dark matter to explore the formation and evolution of large cosmic structures, like galaxies and galaxy clusters. Roman will also survey hundreds of millions of stars to discover what planetary systems around other stars are like.

The telescope's primary mirror is 2.4 meters (7.9 feet) in diameter, the same size as the Hubble Space Telescope's primary mirror. Roman will have a primary instrument, the Wide Field Instrument, and a technology demonstration instrument, the Coronagraph. Roman's telescope and Wide Field Instrument are designed to provide excellent optical performance over an enormous field of view, which together with its 18 state-of-the-art detectors will provide sharp images over an area at least 100 times larger than Hubble. The combination of this wide field of view, nimble attitude control system, and location at the Sun-Earth Lagrange point 2 ("L2") make Roman 1,000 times more efficient than Hubble in performing this core survey science.

By the end of 2024, all Roman hardware will be at Goddard for the mission integration and test campaign. The past year included multiple significant mission milestones to each of the major Roman systems and elements:

- For the in-house spacecraft, Roman's flight **Solar Array Sun Shield** assembly delivered this spring and is on track to be completed on schedule. The panels are designed to power and shade the observatory, enabling all the mission's observations and helping keep the instruments cool. In early August 2024, the **Deployable Aperture Cover** successfully deployed before, during, and after several environmental tests simulating the conditions it will experience during launch and in space. Also known as the visor or sunshade, it is designed to keep unwanted light out of the telescope. The Roman spacecraft team also completed the propulsion system and the communications panel (including the High Gain Antenna System) and integrated both into the spacecraft bus.
- Roman's science instrument, the **Wide Field Instrument**, arrived at Goddard in August 2024. This sophisticated camera will survey the cosmos from the outskirts of our solar system all the way out to the edge of the observable universe. Testing of the instrument will continue at Goddard, and it will be integrated onto the Instrument Carrier and mated to the spacecraft this fall, bringing scientists one step closer to making groundbreaking discoveries for decades to come.
- In spring 2024, the Roman **Coronagraph** finished its most thorough round of testing and exceeded the required performance on this state-of-the-art technology demonstration. It then shipped from NASA's Jet Propulsion Laboratory to Goddard in May, and successfully completed initial testing with the Roman spacecraft bus. The Coronagraph will demonstrate the use of actively controlled optics to enable the direct detection of light from giant planets around other stars. Once demonstrated on Roman, similar coronagraph technologies on a future mission will enable astronomers to directly image Earth-sized planets and identify chemicals in their atmospheres, including ones that could potentially indicate the presence of life.
- In April 2024, the ten total mirrors comprising Roman's telescope or **Imaging Optics Assembly**, were aligned and tested as a complete system at L3Harris in Rochester. This proved that light would move through all of the optics in a tightly controlled way so that Roman instruments can operate correctly.

After a successful test deployment at NASA's Goddard Space Flight Center in Greenbelt, MD, clean room technicians inspect the Deployable Aperture Cover for NASA's Nancy Grace Roman Space Telescope. CREDIT: NASA/CHRIS GUNN

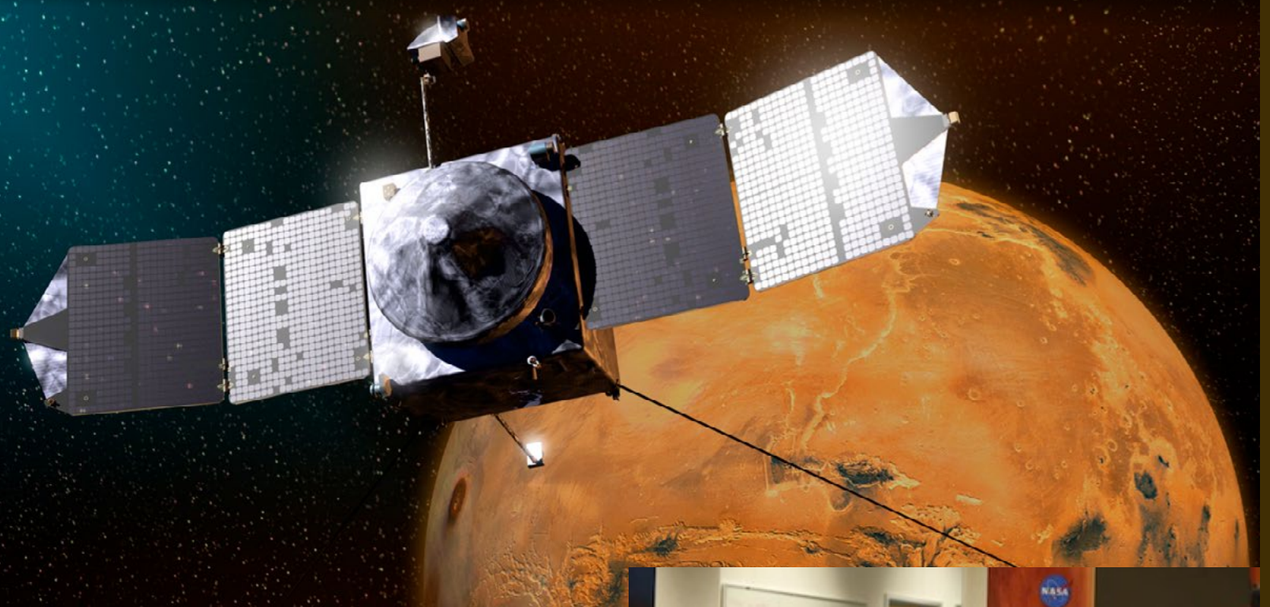
As more Roman developments are made, the latest news and updates can be found on **www.nasa.gov/roman** and @NASARoman on social media. For visual updates of all Roman hardware and systems, visit **roman.gsfc.nasa.gov/interactive/**.

The Nancy Grace Roman Space Telescope is managed at NASA's Goddard Space Flight Center, with participation by NASA's Jet Propulsion Laboratory and Caltech/IPAC in Southern California, the Space Telescope Science Institute in Baltimore, and a science team comprising scientists from various research institutions. The primary industrial partners are BAE Systems, Inc. in Boulder, Colorado; L3Harris Technologies in Rochester, New York; and Teledyne Scientific & Imaging in Thousand Oaks, California. ■

Peter Sooy / Code 448
Roman Space Telescope Outreach Lead

MAVEN HITS DOUBLE DIGITS

NASA's Martian orbiter marks 10 years of scientific revelations



Ten years ago on September 21, 2014, NASA's MAVEN (Mars Atmospheric and Volatile EvolutioN) spacecraft entered orbit around Mars, beginning a decade of exploration of the Red Planet's atmosphere. The mission has produced a wealth of data about how Mars' atmosphere interacts with the Sun and solar wind, and how these interactions drive the loss of the Martian atmosphere to space.

Today, MAVEN continues to make exciting new discoveries that answer key questions about atmospheric evolution and the history of water on the Martian surface, both of which may be key factors for habitability.

In honor of this mission milestone, we celebrate some of the most significant scientific results, the community impact, and the future of this exceptional and long-lasting Mars mission.

Top: Bruce Jakosky, former principal investigator for the MAVEN mission, hugs program manager Guy Beutelschies at Lockheed Martin's mission operations center near Denver after hearing about the spacecraft's successful entry into Mars orbit. Bottom: NASA officials and members of the MAVEN mission team celebrate the probe's successful arrival in Mars orbit on September 21, 2014. CREDIT: NASA

A Decade of Discovery: 10 Groundbreaking Findings from MAVEN

MAVEN is the first mission to Mars that focused on understanding the evolution of its atmosphere. With this goal, the MAVEN team has uncovered several amazing discoveries about the Red Planet. Here we recap some of the most significant findings:

1

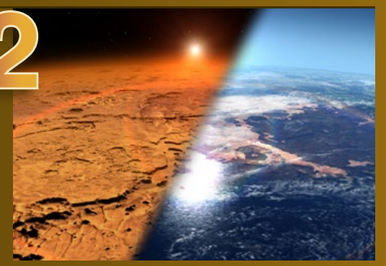
Extreme atmospheric erosion

An early key finding of the MAVEN mission was the erosion of Mars' atmosphere increases significantly during solar storms. The team studied how solar wind and storms strip away Mars' atmosphere, and how this process played a crucial role in transforming Mars from a potentially habitable world to today's cold, arid planet.

Sputtering to space

MAVEN measured argon isotopes in Mars' upper atmosphere to study its atmospheric loss. Argon, a noble gas, is only removed by sputtering—when high-speed ions knock gas molecules out of the atmosphere. When the MAVEN team analyzed argon isotopes in the upper atmosphere, they were able to estimate that roughly 65% of the argon originally present had been lost through sputtering over the planet's history.

2



3

A new type of aurora

MAVEN discovered several types of auroras that flare up when energetic particles plunge into the atmosphere, bombarding gases and making them glow. The MAVEN team showed that protons, rather than electrons, create auroras at Mars. On Earth, proton auroras only occur in very small regions near the poles, whereas at Mars they can happen everywhere.

Martian dust storm

In 2018, MAVEN studied a planet-wide dust storm's impact on Mars' upper atmosphere. The team found that such storms lift water molecules higher than usual, significantly increasing water loss to space.

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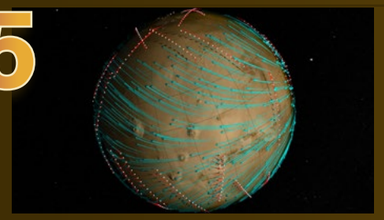

Map of Martian winds

MAVEN created the first map of Mars' upper atmosphere wind circulation, revealing how surface terrain affects high-altitude winds. The results provide insight into how the dynamics of the upper Martian atmosphere have influenced the Red Planet's climate evolution over time.

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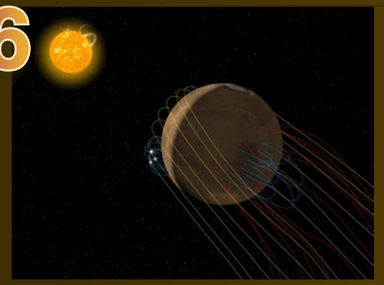


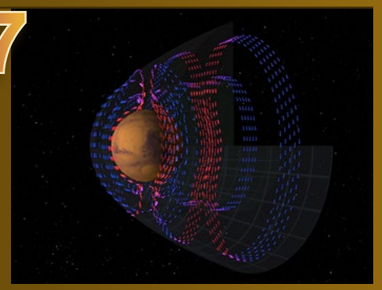
Twisted tail

Mars has an invisible magnetic "tail" that is twisted by its interaction with the solar wind. Although models predicted that magnetic reconnection causes Mars' magnetotail to twist, it wasn't until MAVEN arrived that scientists could confirm that the predictions were correct. The process that creates the twisted tail could also allow some of Mars' already thin atmosphere to escape to space.

Mapping electric currents

Researchers used MAVEN data to create a map of electric current systems in the Martian atmosphere, formed when solar wind ions collide with the planet's magnetic field. The resulting electric currents, which drape around the planet, play a fundamental role in the atmospheric loss that transformed Mars from a world that could have supported life to an inhospitable desert.

7



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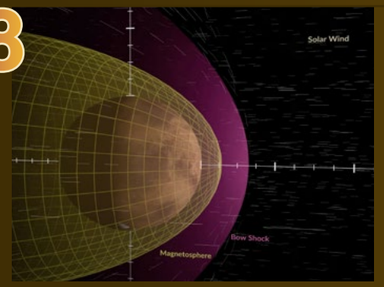

Disappearing solar wind

MAVEN observed the unexpected "disappearance" of the solar wind. This was caused by a type of solar event so powerful that it created a void in its wake as it traveled across the solar system. MAVEN's measurements showed that when it reached Mars, the solar wind density dropped significantly. This disappearance of the solar wind allowed the Martian atmosphere and magnetosphere to balloon out by thousands of kilometers.

Ultraviolet views of the Red Planet

MAVEN captured stunning views of Mars in two ultraviolet images taken at different points along the Red Planet's orbit around the Sun. By viewing the planet in ultraviolet wavelengths, scientists gain insight into the Martian atmosphere and surface features.

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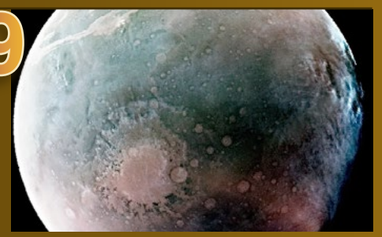


10

Mars' response to solar storms

In May 2024, a series of solar events triggered a torrent of energetic particles that quickly traveled to Mars. Many of NASA's Mars missions, including MAVEN, observed this celestial event and captured images of glowing auroras over the planet.

A Decade of Impact:

Personal stories behind MAVEN's success at Mars

Discover the voices behind MAVEN's successful Mars Orbit Insertion.

Watch "Voices of MAVEN" to hear from the team members who've experienced this groundbreaking milestone back in 2014.

From day one, the MAVEN mission has thrived because of the passionate, talented, and dedicated work of the entire team. To celebrate their contributions to the mission, we are sharing a few of their stories.

Shannon Curry, *MAVEN Principal Investigator*, Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder

"I knew I landed my dream job when I was hired as a postdoc on MAVEN with Janet Luhmann, one of the women who helped develop the very concept of the mission. I wanted to know everything I could about the science, the spacecraft, and the people. Little did I know that I would become the Principal Investigator of the mission someday, now my current dream job. This mission has been the most rewarding and pivotal experience of my professional career, and this team and this mission really do feel like family."

Sarah Henderson, *Postdoctoral Research Scholar*, Montana State University

"The MAVEN mission has meant everything to me as I've begun my scientific career. It has shown me some of the ins and outs of planetary missions, what it takes to do excellent science, and has led to professional and personal connections that will last for years to come. Not to mention, MAVEN has also demonstrated to me just how rad Mars is and how much there is we have yet to discover. Go MAVEN!"

Sergey Shuvalov, *Research Associate*, LASP

"In 2017, I began analyzing MAVEN data while working in another country. Prior to that, I hadn't planned to continue my academic career after completing my PhD, as I believed most major discoveries in heliophysics had already been made and that the potential for new insights was limited. However, MAVEN data has shown me that there is still much to explore in the field, and thanks to this, I now have no intention of leaving academia."

Rich Burns, *MAVEN Project Manager*, NASA GSFC

"The story of MAVEN is one of team resilience and tenacity. Overcoming the significant challenges of the transition phase (after MOI (Mars Orbit Insertion) before start of science), (replanned) aerobraking, loss of an IMU (Inertial Measurement Unit), unusually precipitous safe modes, and so on. Our team is innovative and bold–we do what it takes to bring home the science...and we'll continue to do so."

Nick Schneider, *Instrument Lead for Imaging Ultraviolet Spectrograph (IUVS)*, LASP

"MAVEN really helped me see clearly how 'it takes a village' to make a great mission. Early on, I recall sitting around a table with engineers, managers, budgeteers, scientists, operations folks and more. As we thought about how to pull this off, each person was aware they couldn't succeed without every other person around the table. And each was thinking, 'I have the best job.'"

Gina DiBraccio, *Acting Director Planetary Science Division*, NASA Headquarters

"The MAVEN mission has impacted the science community by providing valuable data to help us to understand the Martian system and allow us to compare the Martian atmosphere with that of other planets, including exoplanets. The mission has also provided valuable lessons that are being applied to new missions today. The MAVEN team has become my professional family over the years. I've been working with these colleagues for more than a decade and have gotten to enjoy many memories with them. We've mitigated problems and celebrated successes together. I'm so proud to be a part of this mission and work with an amazing team."

Continued on page 12

Continued from page 11

Experience MAVEN's Decade at Mars:
A Visual Journey

Explore 10 years of groundbreaking discoveries in our new video:

https://svs.gsfc.nasa.gov/14690/

MAVEN's Legacy:
Charting the Course for Mars' Next Frontier

With over 22,000 orbits around Mars, the MAVEN team continues to demonstrate exceptional ingenuity and resourcefulness throughout the mission. By implementing creative solutions to unforeseen challenges, such as optimizing orbital trajectories and refining data collection methods, the team has maximized MAVEN's scientific output while minimizing resource consumption. This adaptability and problem-solving prowess have not only ensured the mission's longevity but have also set new standards for efficient spacecraft operations. The team's ability to balance scientific goals with operational constraints showcases their expertise and dedication to advancing our understanding of Mars.

In its first decade at Mars, MAVEN has vastly expanded our understanding of the Red Planet and its climate history. Today, it continues to be a critical member of NASA's Martian fleet, observing the interaction between the solar wind and the Martian atmosphere and providing a window into the ongoing evolution of Mars.

"It is an incredibly exciting time for the MAVEN team as we celebrate 10 years of Martian science and see the tremendous impact this mission has had on the field," said Shannon Curry, the principal investigator of MAVEN and a researcher at the Laboratory for Atmospheric and Space Physics at the University of Colorado Boulder. "We also look forward to the future discoveries MAVEN will bring." ■

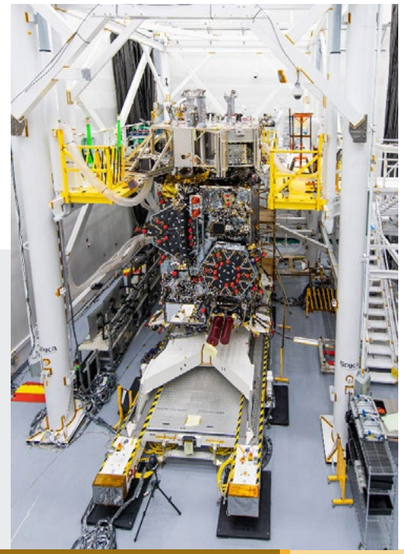
Willow Reed / LASP
MAVEN Communications Specialist

Kelly Hyde / 444
SSMO Chief of Staff

MAVEN
Mars Atmosphere and Volatile Evolution Mission
CU/LASP • NASA GSFC • UCB/SSL • LM • NASA JPL

RECOGNIZING THE
On-orbit Servicing, Assembly and Manufacturing 1 (OSAM-1) Mission Team

FPD wanted to recognize the OSAM-1 team for their outstanding dedication. The Agency's decision regarding the mission does not in any way undermine the success that the team has made towards this cutting-edge space technology nor the outstanding quality of the team over the years. The work over the last year to realign the cost and schedule and performance against that plan has been phenomenal.



The OSAM payload in Goddard's Integration and Test Complex. CREDIT: NASA

Thank You

Please join us in expressing our most sincere gratitude to all that have contributed to the OSAM-1 mission for their expertise and service.

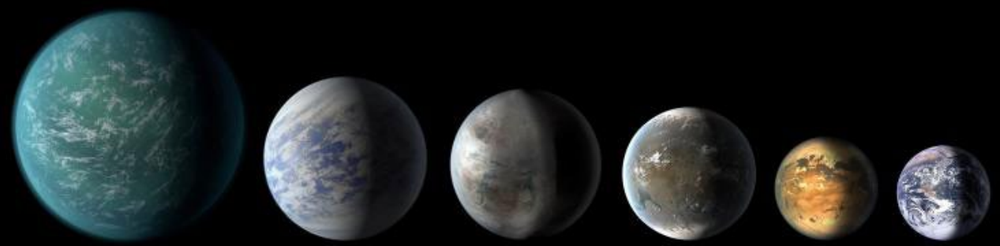
NASA • USGS • MAXAR
OSAM-1
ON-ORBIT SERVICING, ASSEMBLY & MANUFACTURING MISSION
EXPLORATION & IN-SPACE SERVICES

A Tribute to
OSAM-1's Milton Davis

FPD and the OSAM-1 project would be remiss not to recognize one of our most memorable team members, who passed earlier this year. Milton served NASA for more than 24 years, directly contributing to the success of some of NASA's highest profile assets. Milton was an integral part of the OSAM-1 mission, recently serving as the Space Vehicle Manager. His leadership allowed for a strategic approach for planning, executing and identifying milestones for the space vehicle. Milton was the embodiment of technical excellence, supporting and enabling Goddard's mission through a variety of key roles including: System Engineer, Mechanical Systems Engineer, and Aerospace Engineer – and was always willing to step up to any challenge.

Milton's passion for NASA's mission was unmatched, but it was his passion for people that will be missed the most.

HABITABLE WORLDS OBSERVATORY



PIA19830: Pantheon of Planets Similar to Earth (Artist's Concept). CREDIT: NASA/JPL

Simulated image of a Solar System analog 30 light-years away, as captured by a large Infrared/Optical/Ultraviolet space telescope. Read more CREDIT: STSCI, NASA/GSFC

What is the Habitable Worlds Observatory?

The Habitable Wolds Observatory (HWO) is NASA's next flagship astrophysics mission after the Nancy Grace Roman Space Telescope (RST) designed to search for and characterize habitable planets beyond our solar system. HWO would be NASA's first mission designed to look for signs of life on Earth-like exoplanets while addressing astrophysics' three most fundamental questions: "Are we alone?" "How did we get here?" and "How does the universe work?"

Creating a "Super Hubble"

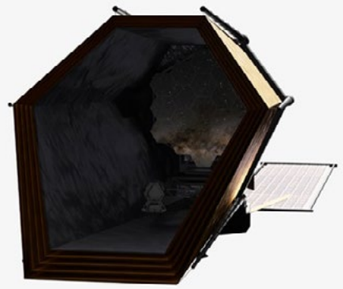
Building upon earlier mission concept studies, HWO's main objective will be to identify and directly image at least 25 potentially habitable Earth-like planets next to relatively bright stars like our Sun using a large ultraviolet, optical, infrared space telescope. Often referred to as a "Super Hubble," HWO will observe wavelengths of light similar to those detected by the Hubble Space Telescope (HST). The telescope will suppress the light from the central star, enabling direct observation of the planet and its atmosphere. It will then use spectroscopy to search for biosignatures in the atmospheres which could serve as evidence for life. Furthermore, HWO will leverage on the foundation of past flagships such as HST and the James Webb Space Telescope (JWST) to revolutionize our understanding of cosmic ecosystems.

Technology Maturation Project Office at Goddard

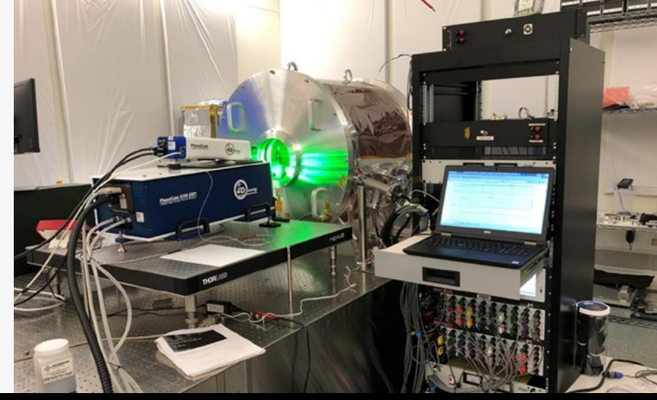
NASA's Goddard Space Flight Center has been selected to establish the HWO project office, beginning with activities focused on identifying and maturing the cutting-edge technologies needed for this next flagship astrophysics mission planned to launch in the 2040s. Over the next few months, the Technology Maturation Project Office (TMPO) will refine a series of complex science objectives, forge new industry partnerships, utilize lessons learned from past missions, and develop a top-level pre-formulation plan that includes organizational management structure and the technology maturation roadmap.

HWO Technology Gaps and Working Groups

Observing for signs of life on an Earth-like exoplanet that is light years away will require an extremely large and ultra-stable telescope with a highly advanced wavefront sensing and control system. The level of stability required is in the picometers – about 1,000 times more precise than JWST. To begin testing these precise measurements in a stabilized and acoustic environment, NASA established an Ultrastable



This is an updated render of Exploratory Analytic Case (EAC) 1 for the Habitable Worlds Observatory. It is unlikely that this will be the final version of the telescope's architecture. Read more CREDIT: NASA



The Ultra-stable Structures Laboratory at NASA Goddard will assist engineering and design of next-generation, large, ultra-stable telescopes to detect and characterize Earth-like planets around distant stars. Read more CREDIT: NASA

Testbed team and the Ultrastable Laboratory at Goddard. This team has already made significant progress in measuring picometer-level disturbances and controlling millikelvin temperature variations. They are currently developing a second-generation test facility which will be used to characterize and advance key telescope technology being developed by industry teams at BAE Systems, L3Harris Technologies, and Northrop Grumman.

Additionally, NASA has established various community working groups to begin guiding HWO's early mission concept activities. This includes four science working groups with key themes such as Living Worlds, Evolution of Elements, Galaxy Growth, and Solar System in Context – as well as working groups focused on servicing, artificial intelligence/machine learning, post-processing, and integrated modeling. Furthermore, a systems team comprised of engineers from multiple NASA centers has been developing first round mission architectures known as Exploratory Analytic Cases that are essentially "strawman" designs used to explore the HWO trade space. While the cases studied are not expected to become future baseline designs, they are important to understanding end-to-end modeling capabilities and identifying challenging issues far in advance of the detailed design. This work will continue through 2024 under the management of Goddard's HWO TMPO.

Servicing Capabilities

Another key topic of discussion is exploring in-space servicing techniques and advancing capabilities to servicing HWO at the Sun-Earth Lagrange Point 2 (SEL2). Currently, there are no servicing capabilities to this point, which limits the expected operational lifespan of current observatories, like JWST. The ability to upgrade and maintain an observatory in orbit at SEL2 would profoundly enhance scientific performance and maximize return on investment. However, there is a long road ahead, and there are many options to consider. Goddard recently supported an "Exploring Servicing Capabilities for HWO" Workshop in August 2024 in collaboration with the University of Maryland to discuss the various approaches to this dilemma with subject matter experts from academia, industry, and government. This larger community collaboration is essential to meeting these complex challenges head on, and the TMPO team is committed to bridging the gap.

Path Forward

HWO will be revolutionary in our quest to find habitable Earth-like planets beyond our solar system, and its new observational capabilities will further our understanding of the origins and evolutions of galaxies. By leveraging our expertise at developing major space telescopes and utilizing decades of lessons learned from flagships such as HST, JWST, and RST, HWO is set to keep Goddard positioned as one of the world's leading science and engineering centers as we work with our partners in industry, academia, and other NASA centers to make HWO a success. These early developments in technology, mission architecture, budgeting, and programmatics are crucial to enabling HWO to deliver transformational astrophysics discoveries in the 2040s and beyond. ■

Rachel Bushey / Code 440
Astrophysics Projects Division
Technical Writer

PUNCH Launch to Study How Sun's Corona Creates Heliosphere and Solar Wind

The Explorers and Heliophysics Projects Division's (EHPD; Code 460) Polarimeter to UNify the Corona and Heliosphere (**PUNCH**) is a NASA Small Explorer (SMEX) mission that will **investigate solar wind formation** and the role the mass and energy of the Sun's corona play in our solar system.

Artist's rendition of the PUNCH constellation in Sun-synchronous LEO. CREDIT: SWRI/NASA

PUNCH comprises four suitcase-sized satellites that will take continuous, synchronized images of the inner solar system. A Class D mission, PUNCH was selected for a Phase A concept study on July 28, 2017. Since then, it has progressed through the project lifecycle and is now on target to launch as a rideshare with the Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx) mission aboard a SpaceX Falcon 9 from Vandenberg Space Force Base by April 1, 2025.

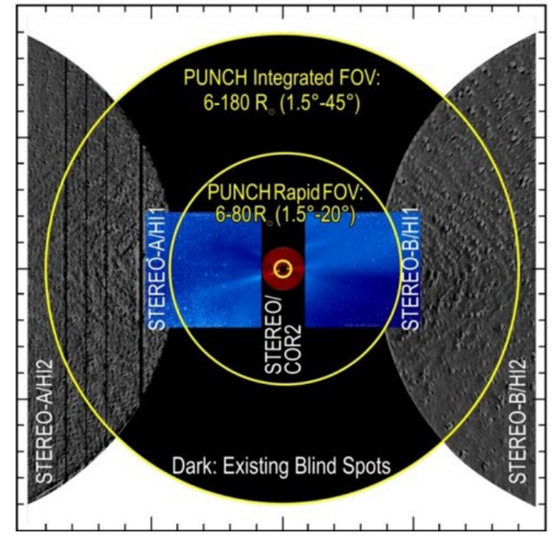
In partnership between NASA, the Southwest Research Institute (SwRI), the Naval Research Laboratory (NRL), and Rutherford Appleton Laboratory (RAL) Space, PUNCH will image the solar corona and inner heliosphere as a single, unified physical system.

According to PUNCH Principal Investigator (PI) Dr. Craig DeForest, PUNCH builds on efforts going back over 60 years. NASA has studied the "solar wind", a hypersonic stream of plasma composed mainly of free protons and electrons and magnetic field, since its existence was **confirmed with in situ measurements** by the Mariner 2 mission to Venus in 1962. The 1974 Helios-1 mission, which studied the solar wind throughout the inner solar system, demonstrated that the solar wind could be seen with visible light cameras. These efforts have continued through missions such as NASA's Solar Terrestrial Relations Observatory (**STEREO**), whose mission to study the structure and evolution of solar storms launched in 2006.

Together, five instruments on each STEREO spacecraft (**A and B**) formed the Sun-Earth Connection Coronal and Heliospheric Investigation (**SECCHI**) imaging suite. (STEREO-A, still in operation today, **recently imaged solar storms** in May 2024.) However, it wasn't until 2011 that a team of scientists, led by DeForest, discovered how to remove the starfield from STEREO images to see clearly the solar wind itself, in addition to the large eruptions of plasma and magnetic field from the Sun's corona known as coronal mass ejections (CMEs).

PUNCH forms a single dedicated "virtual instrument" that will build on the lessons learned from SECCHI. Not only will PUNCH track CMEs, but it will also generate three-dimensional images of the solar wind itself and seek to understand how mass and energy from the Sun's corona **become solar wind**. Specifically, PUNCH will produce polarized visible-light images of the outer corona and inner heliosphere continuously over the course of its two-year mission, separating the faint signal of sunlight Thomson-scattered off free electrons in the solar wind from the far brighter starfield and galaxy behind the Sun.

PUNCH Builds on STEREO



PUNCH will improve on STEREO's accomplishments with greater temporal and spatial resolution. CREDIT: SWRI/NASA

While STEREO identified the transition to coronal flow about 10° from the Sun, PUNCH will view this same region with three to 10 times better spatial resolution and 10 to 30 times better sensitivity.

As PUNCH Project Scientist Dr. Sarah Gibson puts it, the Sun is unique because, among all stars, it is the only one to directly impact humans on Earth, both through daylight and through space weather. PUNCH will observe both the ambient solar wind that sweeps past the Earth and drives geomagnetic activity, and the dynamic events, such as CMEs, that cause space weather around Earth. PUNCH will track these features in three dimensions as they streak away from the Sun in all directions.

PUNCH employs a novel mission design by placing four microsatellites (MicroSats) in a Sun-synchronous orbit around the Earth. These MicroSats, suitcase-sized satellites larger than

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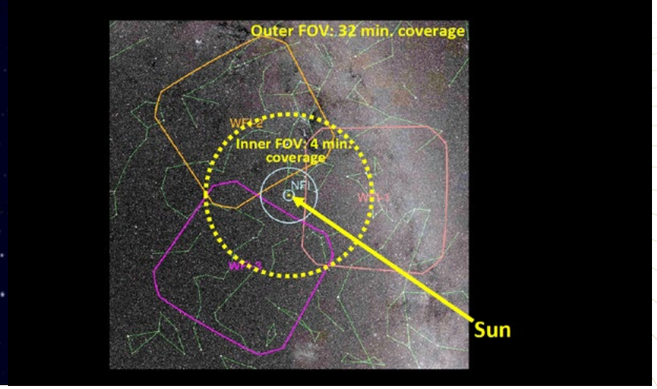
PUNCH MicroSat fleet in Sun-synchronous orbit around Earth.
CREDIT: SWRI/NASA



PUNCH sweeps its full field of view (FOV) three times each orbit.
CREDIT: SWRI/NASA

CubeSats but smaller than traditional satellites, operate as a single "virtual observatory" as large as their orbit around our planet. This permits viewing at all angles around the Sun, out to 45° from the Sun itself, continuously from low Earth orbit.

The constellation of four MicroSats collects images simultaneously to within ±1 second, using Global Positioning System signals to synchronize the on-board clocks. Each dataset is then integrated on the ground into a single composite image, once every four minutes.

The MicroSats themselves are interchangeable, and each hosts one primary instrument. Three host Wide Field Imagers (WFIs) spaced 120° apart in orbit, and one hosts a Narrow Field Imager (NFI) in an unconstrained orbit. Together, these observatories sweep the complete PUNCH field of view, a circle 90° across and centered on the Sun, three times each orbital period.

Although this approach is relatively novel from a mission persecutive, PUNCH can achieve this with current technology. However, major operational innovations were required for the PUNCH ground system, where technical challenges at the Science Operations Center (SOC) were immense. The PUNCH SOC team had to develop new techniques to represent polarized light in order to remove polarized backgrounds on the sky, and needed to remove 99.95 percent of light from each image without destroying the desired signal data from the solar wind.

Images from PUNCH must be resampled and matched onto merged data products more precisely than is possible even for most single-field telescopes. PUNCH will co-align the starfield from different cameras to within less than 1/30th of a pixel, and each camera will have to be photometrically calibrated to within 0.05 percent relative to one another on an ongoing basis.

Additionally, PUNCH had to contend with other, perennial calibration challenges. For example, the SOC team had to address point-spread function (PSF) correction for each imager and bring them together as a single, idealized virtual instrument. Specifically, they had to develop novel algorithms to remove the blurring effects present at the edges of images due to PSF, an issue that has plagued astronomers since Johannes Kepler wrote about it in the 17th century. Of course, humanity's fascination with the cycles of the Sun stretches back even further.

PUNCH Mission Scientist Dr. Nicholeen Viall notes that humanity has always needed to know, track, and measure the Sun. To that end, PUNCH's outreach and engagement philosophy is to shine new light on ancient and modern sun watching to expand both scientific and public understanding of our star.

From Bronze Age Stonehenge in Britain to the ancestral Puebloan petroglyphs in Chaco Canyon in northwestern New Mexico, archaeoastronomy continues to illuminate a sustained human relationship to the Sun across cultures and time. As the **PUNCH outreach program** notes, one of Chaco Canyon's petroglyphs may depict the 1097 total solar eclipse, which would make it "**the oldest known representation of a solar storm in the corona**."

In the current century, it's that same fundamental sense of curiosity that propelled Viall to ask questions that would lead to the development of one of PUNCH's investigative goals. After attending a STEREO mission presentation DeForest gave at NASA's Goddard Space Flight Center (Goddard), she challenged the notion that fluctuations in the data obtained were due to random turbulence alone. Rather, she proposed that they came directly from the Sun. The ensuing debate and discussions resulted in tuning the science objectives and measurement requirements of PUNCH to answer this question.

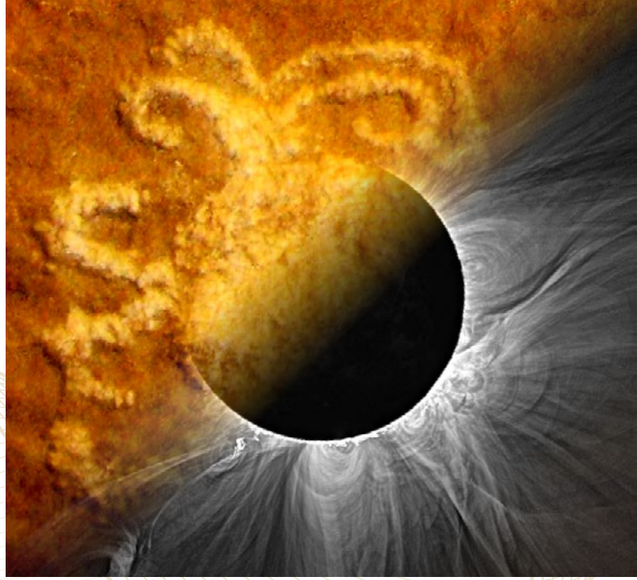
Today, PUNCH aims to replicate the effects of a total solar eclipse in order to better observe the corona. As Viall describes, PUNCH will create an artificial eclipse (as all coronagraphs and heliospheric imagers do), in two ways. First, coronagraphs accomplish this via an occulter device to block out the majority of the Sun while leaving the corona visible, a method employed on PUNCH's single NFI. Its three WFIs will accomplish similar results by observing the Sun at an angle and using baffles designed to minimize the stray light.

This complex constellation configuration required close collaboration between several organizations, with each bringing a different skillset to the table. SwRI provided the PI, Project Manager (PM), WFIs, and payload/observatory integration and testing, as well as the Mission Operations Center and the SOC. NRL provided the NFI and polarized filter wheel. RAL Space provided camera assemblies, and NASA Goddard provides programmatic oversight through the Explorers Program Office

According to PUNCH PM Ronnie Killough, PUNCH took on many forms throughout development before settling on the current mission configuration. PUNCH was initially to be the primary payload on a Pegasus launch vehicle until changing to the current launch plan (as a rideshare with SPHEREx on a deployer ring) which occurred after Preliminary Design Review (PDR). As rideshares of this nature are a newer process, PUNCH is again paving new ground as programmatic and technical rideshare processes are developed and refined.

The combined PUNCH team has navigated various obstacles across the mission lifecycle, yet has handled each of them in stride. From challenges encountered with remote work during the COVID-19 pandemic, to hardware failures and more, the team has overcome each hurdle.

Notably, the lenses inside the Optical Lens Assembly (OLA) came loose during instrument-level vibration testing. The SwRI and the Explorers program worked with the vendor to determine the cause of failure,



Composite of ancient and modern depictions of the solar corona. Upper left: petroglyph of solar eclipse viewed in 1097 (Chaco Culture National Historical Park). Lower right: high-resolution observation of 2013 solar eclipse (© 2013 Constantinos Emmanoulidis, © 2014 Miloslav Druckmüller). CREDIT: SWRI, CONSTANTINOS EMMANOULIDIS, MILOSLAV DRUCKMÜLLER

resolving the issue with enhanced bonding on the lenses. In an effort to mitigate cost and schedule impact, SwRI and the vendor worked together to come up with a novel solution without requiring a full OLA re-design, which would have taken significantly more time and money.

The PUNCH team resolved a recent radio failure in a similar manner. The problem arose during NFI Observatory Thermal Vacuum (TVAC) testing. After a six-week investigation, the team identified the root cause as thermal runaway due to a design flaw in the radio discovered by the vendor during the subsequent investigation. This flaw had not been discovered previously because, while PUNCH was using the hardware within product specifications, it was not being operated in the same way as before. The resolution required all four observatories to be disassembled to gain access to the radios for rework.

PUNCH could have passed this issue back to the vendor to fix on their own, but again, the team instead worked collaboratively with the supplier to identify the problem, develop a solution, and appropriately divide the rework between the vendor and SwRI most effectively from cost, schedule, and technical perspectives. The PUNCH team's ability to maintain a strong focus on mission success, rather than strictly on contractual obligations, was key to resolving both the OLA and radio failure problems.

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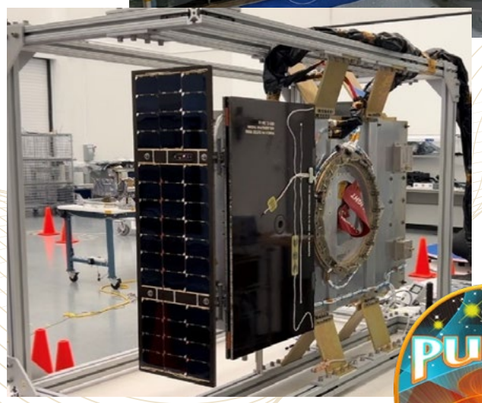
As a result of this collaborative approach, all radios were successfully reworked and all four observatories have been reintegrated. Two observatories will re-enter TVAC testing in early October, with the testing plan revised to TVAC-test the observatories in pairs for cost and schedule savings. While this failure pushed project reserves to their limits, the Program Office worked with the project and other stakeholders to address the cost and schedule impacts. However, in addition to addressing technical challenges, PUNCH has also overcome multiple programmatic hurdles.

Explorers Mission Manager Tyrone Dillard notes that many of the challenges PUNCH faced had to be resolved remotely due to COVID-19 restrictions put into place less than six months after the start of Phase B. The Explorers Program Office encountered the as-then-unique hurdle of managing multiple external mission partners in a restrictive hybrid telework environment. During that time, NRL (in the United States) and RAL Space (in the United Kingdom) supplied the NFI and cameras, respectively, for PUNCH observatories, all of which were managed remotely by SwRI and the Explorers Program Office.

Moreover, failures due to camera anomalies had to be resolved while entirely remote, with RAL Space onsite troubleshooting and remote failure review boards. Both the Program Office and SwRI attended, advised on troubleshooting, and assisted confirmation and resolution of root causes. The Program Office also assisted with the Safety and Mission Assurance plan and completed inspections during the pandemic. Many of PUNCH's critical avionics subsystems had to be inspected remotely, providing mission assurance oversight and supporting programmatic cost and schedule mission goals. This allowed Explorers to execute Government Mandatory Inspection Points while maintaining health and safety precautions.

As DeForest notes, PUNCH represents the beginning of a new era where constellation missions are more feasible due to commercial space advances and low-cost development. PUNCH is a trailblazing mission in this new paradigm, and the entire team has succeeded in developing a truly innovative, first-of its-kind mission. After overcoming many hurdles to get to this point, PUNCH's hopeful success will serve as a guidepost for other missions. Moreover, the science PUNCH accomplishes will help unlock the secrets of our star and light the way for future heliophysics investigations. ■

J. Titus Stupfel / Code 460
Explorers and Heliophysics Projects Division



Top: The first test image taken by PUNCH's WFI-1 observatory on April 26, 2024. Middle: PUNCH NFI Observatory in TVAC Chamber. Bottom: PUNCH WFI-2 Observatory in Final Integration CREDIT: SWRI

OUT & ABOUT

LIFE'S HIGHLIGHTS OFF CAMPUS

(left): Baby Violet; (right): Mom Sarah Milam with Violet. CREDIT: BRUCE MILAM

Bruce Milam (Code 401.1) is thrilled to announce the birth of his second grandchild, Violet Findlay Milam. She was born on June 27, healthy 19.5 inches and 8 lbs. 2 oz. At 2.5 months she had her first plane ride, then flew to Summersville, WV to meet her great grandmother. She is not impressed by planes and sleeps most of the time. Violet loves mom and dad and really wants to be able to walk like Fletcher her brother, who is 2.5 years old. Her parents are Josh and Sarah Milam of Crownsville, MD, her grandparents are Bruce and Debi Milam, and her Aunt is Liz Hoy (Code 618).

(left): Baby Bella; (right): Proud parents Jordan and Paige with Bella. CREDIT: PAIGE MCKINLEY

Best wishes to Paige (Wood) McKinley (Code 460) and her husband, Jordan, on the birth of their first child, Bella Alayna, on October 24, 2024. She weighed 6 lbs. 4 oz. and was 19 inches long. Her Mimi, Paula Wood (Code 460), and her Aunt, Pamela Merkel (Code 155.7), are so very excited to spoil her rotten!

Congratulations and best wishes to Ryan Carney (Code 474) who married Cristina Rodriguez in Baltimore, Maryland on October 6.

Christina and Ryan.
CREDIT: RYAN CARNEY

Share your news!
Weddings, births, interesting travel experiences…we want to know!

Please send your inputs to Paula Wood. Include your **name, phone number** to:

paula.l.wood@nasa.gov
Code 460
Ext. 6-9125

Comm and Nav Interns Shape NASA's Future

SIP interns visit the Near Space Operations Control Center (NSOCC) to play flight controllers and astronauts in the communications activity "Down to the Wire." CREDIT: NASA/DAVE RYAN

For nearly a decade, the Space Communications and Navigation (SCaN) program has emphasized the importance of developing the next generation of Comm and Nav leaders and innovators. The SCaN Internship Project (SIP) expands on NASA's traditional internship program, providing its interns with additional mentor support, professional development workshops, networking events, one-on-one program guidance, and a close-knit intern cohort. At Goddard Space Flight Center, SIP endeavors to give interns the resources they need to excel in the NASA workforce and immerse themselves in Goddard's Comm and Nav Community.

SIP provides year-round support to SCaN interns across Goddard's Maryland, Virginia, New York, and New Mexico campuses, with a special emphasis on the summer term. Over ten weeks, SIP interns contribute to missions across the Near Space Network while developing their professionalization skills. This year's intern projects supported and expanded the Near Space Network's capabilities across a wide spectrum — in some cases, even parts of the actual electromagnetic spectrum itself.

From June to August, 21 interns across 14 states, 17 schools, and 11 majors joined the program for one of its most successful summers yet. These interns worked on bringing reliable search and rescue beacons to the Moon, building digital and physical models of optical ground stations, developing the foundational parameters of lunar internet, and much more. As they contributed to the advancement of the Near Space Network, they developed their own skills as researchers, speakers, collaborators, and members of the workforce at NASA and beyond.

It was a summer rich with programming highlights for SIP interns participating virtually and on center. At the start of the session, interns built their critical thinking and communications skills under pressure while playing "flight controllers" in a teambuilding exercise (image above). Throughout the session, they had the opportunity to engage with program and project leaders. Interns met the SCaN leadership at Goddard, Glenn Research Center, and Headquarters; received career advice from Associate Director of Flight Projects, Bob Menrad and his successor Patrick Hill, and participated in a frank discussion about project management with the Director of Flight Projects, Cathy Richardson and Deputy Marlo Maddox. Interns also learned about NASA partnerships, like the National Oceanic and Atmospheric Administration's (NOAA) communications and research conducted in McMurdo Station, Antarctica.

After visiting the Wallops Flight Facility's (WFF) Ground Monitor and Control Center, interns make their way to a WFF ground station. CREDIT: NASA/JIMMY ACEVEDO

Intern Kate Oberlander shares her Lunar Communications Relay and Navigation Systems (LCRNS) project research at SIP final presentations. CREDIT: NASA/KASEY DILLAHAY

On center, interns found ways to explore the Greenbelt campus beyond their motorized scooters. They toured the Electromagnetic Anechoic Chamber and microwave lab, NOAA's Satellite Operations Facility, and visited the Wallops Flight Facility for a behind-the-scenes tour of the SCaN ground support infrastructure (left image above). They explored the Greenbelt campus in an intern-led radio foxhunt and practiced tracking low Earth orbit amateur relay satellites outside the Visitor's Center. SIP interns expanded their social network while chatting over hotdogs at the Exploration and Space Communications (ESC) division picnic and learned more about the private sector during Goddard's Career Fair. It was the liveliest SIP summer Greenbelt has seen since 2019!

Most importantly, SIP interns gathered both virtually and in person to showcase their impressive summer projects during the program's capstone event: final presentations (right image above). Over 250 people attended the interns' presentations and celebrated their contributions to the Agency. From lunar search and rescue to ground station modeling, amateur radio to quantum clock synchronization, and educational activities to testing toolkits, the interns have left an indelible mark on our community and the Agency. This summer's projects produced three papers pending publication, three New Technology Reports, and two Agency-wide Shining Star intern awards — an honor granted to only five interns out of a population of over 1,200!

Of course, this is only the beginning of these students' professional journeys. Former SIP interns have gone on to build Mars rovers, retrieve the Orion capsule, design the Space Launch System communications antenna, and lead the internship program itself! As the Comm and Nav Community celebrates today's successes, it also looks ahead to what these interns — and the 2025 SIP community — will achieve tomorrow.

Korine Powers / Code 450
ESC Projects Division Senior Writer & Education Lead

LENGTH OF SERVICE PERSPECTIVES
FROM THE DIRECTORATE

NASA, Goddard, and the Flight Projects Directorate pride themselves on the dedication of our exceptional workforce. Please join us in congratulating the four civil servant employees who reached career milestones over the past year. These team members have devoted substantial portions of their career to the Federal Government and their perseverance and commitment enables NASA's mission.

35 YEARS

Ame Fox

Space Weather Next (SW Next) Program Lagrange Point 5 (L5) Deputy Project Manager

What do you recommend to stay motivated and positive at work?

Always find the wonder to feed your excitement in the incredible work we do. It's exciting to be a part of launching missions that bring science to the public. Don't lose sight of that mission.

35 YEARS

David Israel

ESC Projects Division/Near Space Network Chief Architect and Laser Communications Relay Demonstration Principal Investigator (PI)

Reflecting, what has been the best part of working at NASA/GSFC/FPD?

I have spent my whole career working on many space communications projects and the best part is being part of the tradition of working with the wide variety of people to enable the success of so many missions.

30 YEARS

Susanne (Susie) Strege

JPSS Advanced Technology Microwave Sounder (ATMS) Deputy Instrument Manager

Reflecting, what has been the best part of working at NASA/GSFC/FPD?

The best part about working at NASA GSFC is performing work that helps the entire world to better understand itself and live in a safer place. In my 30 years, I've worn many hats each connected to a great purpose, taking part in something big, something out of this world!

10 YEARS

Kelly Hyde

Space Science Mission Operations Project, Chief of Staff

What do you recommend to stay motivated and positive at work?

Staying motivated at NASA Goddard involves embracing the multifaceted nature of your work. Engage in outreach activities to inspire others and share NASA's mission. Focus on the groundbreaking aspects of projects like returning asteroid samples, recognizing your role in making history. Find excitement in spacecraft operations, knowing your contributions are crucial to space exploration. Appreciate your colleagues and the diverse talents they bring to the team. Regularly connect your daily tasks to NASA's broader mission of advancing scientific discovery. By combining these elements, you'll maintain enthusiasm for your work, knowing you're part of a team making significant contributions to human knowledge and space exploration.

40 Years

David Lloyd Carter, James F. Jeletic, Tommy Eugene Jones, William J. Potter

35 Years

Tammy L. Brown, Eugene D. Guerrero-Martin, Kevin M. Jones, Kaleem Kawaja, Lori K. Perkins, Ted C. Sobchak

30 Years

Vicki M. Dulski, Beth Ann Keer, John F. Mc Cabe III

25 Years

Arlin Edgar Bartels Jr., Adam J. Matuszeski, John Kwabena Owusu

20 Years

Brian A. Hall, Jason E. Hylan, Olivia L. Lupie, Cathleen M. Richardson, Chetan Sayal, Ronald L. Williams

15 Years

Andrew Wild Bates, Rita A. Grullon-Pingon, Matthew Eric Handy, Eric Joseph Harris, Alan Guy Hylton, Obadiah Oseko Kegege, Cody Patrick Kelly, Jerry Lee Mason II, Stephanie Lia Vidal

10 Years

Ruma Das, Angela Marie Hodge

2024
Code 400
FPD
Peer Awards
& Achievements

Congratulations to all of the 2024 FPD Peer Award recipients! Thank you to our nominators for their work recognizing our FPD teams and individuals for their exceptional achievements. Please use the link below to view the award recipients.

2024 FPD PEER AWARD RECIPIENTS

2024 ROBERT H. GODDARD AWARD RECIPIENTS

Congratulations to all of the 2024 Robert H. Goddard Award recipients! Thank you to our nominators for their work recognizing our FPD teams and individuals for their exceptional achievements. Please use the link below to view the award recipients.

2024 RHG AWARD RECIPIENTS

JWST Senior Project Scientist Receives Presidential Medal of Freedom

Rigby, who was born and raised in Delaware, is honored with the Medal of Freedom for her role in the success of NASA's Webb mission – the largest, most powerful space telescope launched on Dec. 25, 2021 – as well as her longtime support of diversity and inclusion in science. CREDIT: THE WHITE HOUSE

Congratulations to Dr. Jane Rigby, Senior Project Scientist for the James Webb Space Telescope, who received the Presidential Medal of Freedom at the White House on May 3! The award is "the Nation's highest civilian honor, presented to individuals who have made exemplary contributions to the prosperity, values, or security of the United States, world peace, or other significant societal, public or private endeavors." Jane expressed her feelings about the team effort involving all members of the JWST team with the sentiment "When President Biden called me two weeks ago, I was caught totally off guard. He praised Webb's success, how we're making great discoveries about the early universe and the growth of black holes. I said something about it being a team effort. True, he said, and great teams need great leaders. I don't know if that's true or not; I wasn't going to argue. But for sure, I want to be the best possible scientific leader for this amazing team."

More Information

President Biden Announces Recipients of the Presidential Medal of Freedom | The White House

Former NASA Center Director, Scientist to Receive Presidential Medals - NASA

Patrick Hill

Exploration and Space Communications (Code 450)
Associate Director for Flight Projects

Born Chicago, Illinois

Education Doctor of Engineering, Engineering Management, George Washington University

MS, Systems Engineering/Technical Management, Johns Hopkins Whiting School of Engineering

MS, Aeronautics & Astronautics, Stanford University

BS, Aerospace Engineering, Tuskegee University

Life Before Goddard

Patrick knew he wanted to work in the space industry since the sixth grade. He grew up close to Wrigley Field in inner-city Chicago with his three sisters and mother, Mary, who was a special education teacher in Chicago. While Mary attended graduate school, she worked part-time for the Museum of Science and Industry. During her tenure with the museum, Patrick became a frequent visitor and spent hours upon hours in the Henry Crown Space Center. This is where his love for science – particularly aerospace – grew, as he learned about aerospace milestones like the Moon landing and the Space Shuttle program.

As Patrick approached the sixth grade, he set his sights on becoming an aerospace engineer and began picking classes that supported his career goals. From grade school to high school, Patrick excelled in his studies, and his desire to learn more about aerospace continued to grow.

During his visits to the Museum of Science and Industry, Patrick learned about Tuskegee University in Alabama, the only historically Black college with an aerospace engineering department at the time. He knew at once that the university was the right choice for his career path. Patrick graduated *magna cum laude* from Tuskegee with a Bachelor of Science in aerospace engineering and continued his studies as a graduate student at Stanford University majoring in aeronautics and astronautics with a focus on structural analysis.

Patrick landed a job with Boeing right out of graduate school, where he served as a space structural analyst and provided mechanical design structural analysis on XM Radio, Sirius Radio, DirecTV communications satellite programs, and NASA's very own Tracking and Data Relay Satellite System! Patrick moved to the East Coast to work as a senior space structural analyst and later a business development space systems scientist at Orbital Sciences Corporation where he helped design and build commercial communications satellites and spacecraft for NASA missions. However, the breadth of Patrick's career was spent at Johns Hopkins University Applied Physics Laboratory (APL), where he helped design, build, test, manage, and later oversee several NASA instruments and missions including the Solar TErrestrial RElations Observatory (STEREO), New Horizons, Magnetospheric Multiscale (MMS) Energetic Particle Detector, Parker Solar Probe (PSP), Double Asteroid Redirection Test (DART), and Dragonfly. He was featured in a **PSP project video**.

Patrick continued to advance his education while in the workforce. He received a Master of Science degree in systems engineering/technical management from Johns Hopkins University and later went on to earn his Doctor of Engineering degree in engineering management from George Washington University's School of Engineering and Applied Science prior to joining the Exploration and Space Communications (ESC) division as Associate Director for Flight Projects. Congratulations, Patrick!

Life at Goddard

While Patrick has only been with Goddard for two months, he has already made an impact within the Comm and Nav community. Not only is he personable, but he is open to change and brings a fresh perspective to ESC. As Bob Menrad's successor, Patrick leads an exceptional group of employees dedicated to providing mission-critical communications and navigation services that empower science, technology, and human space flight missions.

"I enjoy working at Goddard," Patrick said. "While there are some challenges, I believe they can be overcome. My goal is to put ESC on a smoother path moving forward [in terms of funding and staffing]."

He is currently working toward realigning some of ESC's projects toward a more holistic approach and ensuring that the Near Space Network has the critical staffing it needs to enable mission success. Patrick has recently added two new Near Space Network mission managers and plans to add two more to cut the workload in half. While these changes are only beginning, we look forward to seeing what ESC will achieve under his leadership.

Patrick recently visited Svalbard, Norway, one of the world's northernmost inhabited areas, where Northern Lights are visible during the winter and summer brings sunlight 24 hours a day. CREDIT: PHOTOS COURTESY OF PATRICK HILL

Life Outside Goddard

Now that he has completed his doctorate, Patrick is adjusting to life outside of the office and academic research. He enjoys traveling around the world, including his most recent trip to Svalbard, Norway, and yearly visits to his alma mater, Tuskegee. Education remains one of Patrick's great passions. He previously leveraged his skills as an aerospace engineer to teach science and engineering classes at Blake High School in Silver Spring, Maryland and hopes to become a collegiate professor later in life. ■

Kendall Murphy / Code 450
Technical Publications Specialist

Brooke Hsu

FPD Project Formulation and Development Office (Code 401)
Associate Director for Formulation

Born New Jersey

Education MA, Science Education, University of Maryland, 2005
BS, Geology, University of Maryland, 2002

Life Before Goddard

Brooke was born in New Jersey but grew up in North East, a small town in Cecil County, MD. A huge band geek in high school, Brooke's ultimate dream was to become a High School Band Director and lead a competitive marching band to an east coast championship. After high school, Brooke attended Howard Community College (HCC), where she realized that maybe being a band director wasn't what she wanted after all. After two years at HCC, Brooke transferred to the University of Maryland (UMD) as an accounting major. An introductory astrophysics course opened Brooke's eyes to planetary science, and she became hooked. Brooke ultimately graduated from UMD with a degree in Geology with a concentration in structural geology since planetary geology wasn't yet offered at UMD.

Life at Goddard

Brooke's first foray into Goddard was as an undergraduate intern in 1998, working under the venerable Dr. Herb Frey conducting research on Mars using Mars Orbiter Laser Altimeter (MOLA) data. During graduate school, Brooke served as the Research Operations Coordinator for Goddard's first Astrobiology Institute, where she managed the Institute's million-dollar annual operations budget and provided support for the Institute's Director, Dr. Mike Mumma. Brooke then returned her focus to her studies full-time, completing her master's degree.

Brooke re-joined Goddard in 2005 as a contractor for the Science Exploration Directorate's Planetary Division as a Science Education Specialist. During her ten years in the Planetary Division, Brooke served on several mission teams, including Aura, Lunar Reconnaissance Orbiter (LRO), MAVEN, MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER), and New Horizons. Brooke and the team pioneered the use of social media for mission related news, events, and science result communications to the general public. This included the first live-tweeting opportunities for the LRO launch, lunar orbit insertion, and lunar eclipse mission operations, including those in the middle of the night whenever the eclipses occurred!

The LRO mission provided Brooke the opportunity to learn first-hand what it meant to be a project manager. She watched LRO be built from the ground up, supporting the mission from Goddard selection through launch. Brooke worked closely with LRO project management to ensure mission development milestones were communicated to the public and educational communities. Brooke's management of LRO Education Lead duties led her to realize she had a knack and a passion for project management. She expressed this interest to the former LRO Deputy Project Manager Cathy Peddie and was offered the opportunity to join the Roman Space Telescope team in 2014.

Clockwise from left: Aloha! Brooke and family on the Big Island, Hawaii; Brooke rappelling at the end of a zipline course in Kohala, Big Island. CREDIT: ALL PHOTOS COURTESY OF BROOKE HSU

When Brooke joined Roman, the project team was small enough to fit in a single conference room. The project was focused on formulation activities and technology development, and Brooke got a front row seat to witness and participate in formulation activities for this flagship Decadal Class mission. That experience was invaluable in understanding what it takes to formulate a large mission, including dealing with new constraints applied to a project from NASA Headquarters. Brooke also supported Roman as the first large mission to have an independent cost review at its Mission Concept Review and have a cost cap applied for pre-Phase A activities.

Brooke continued to support the Roman project team until 2018, just before telescope contractor selection. Brooke was then assigned as the Optical Telescope Assembly (OTA) Manager for contract evaluation activities. Impressed with Brooke's support, Roman's Deputy Project Manager assigned Brooke as the Deputy OTA Manager. She continued to support the OTA through contract ratification, early telescope milestones, and the first three Engineering Change Proposals.

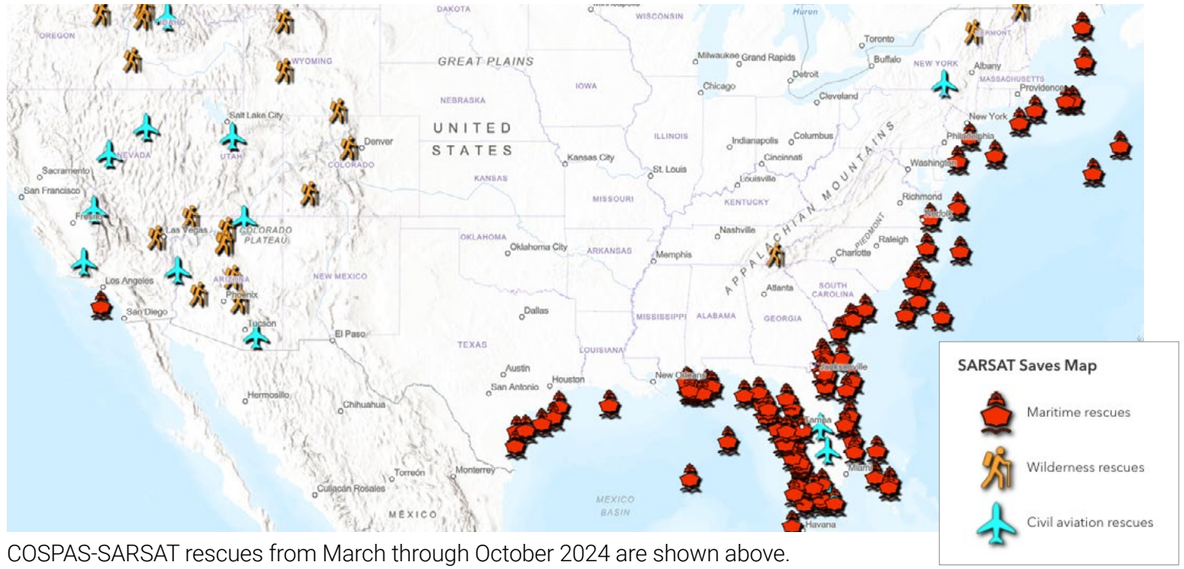
In 2021, Brooke applied to an Agency-wide ad for project managers and was selected to join the Project Formulation and Development Office (PFDO) as a civil servant. As a member of PFDO, Brooke formulated small NASA Procedural Requirement (NPR) 7120.8 research and technology instruments as well as billion-dollar NPR 7120.5 missions. In April 2024, Brooke was selected to lead PFDO as the Associate Director for Formulation.

Life Outside Goddard

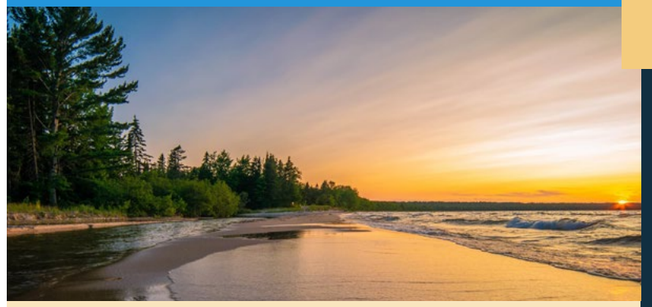
Outside of work, Brooke enjoys spending time with her family, including her husband and middle school-aged twins. Additionally, Brooke enjoys traveling, cooking, camping, and fishing. On any given Friday night, Brooke can be found hosting game night for a group of like-minded gaming geeks. ■

THE LATEST SAR SAVES

NASA'S SEARCH AND RESCUE (SAR) OFFICE CONTINUES ITS EFFORTS TO DEVELOP AND IMPROVE ON LIFE-SAVING DISTRESS BEACON TECHNOLOGIES.



COSPAS-SARSAT rescues from March through October 2024 are shown above.



The day after Thanksgiving is Native American Heritage Day, honoring the cultures, history, and contributions of Native Americans and Alaska natives. Established in 2009, this holiday is based on the tradition of the first meal shared between European settlers and Native Americans. Find out more about how to celebrate during the National Native American Heritage month of November at: **https://www.bia.gov/NNAHM**.

DID YOU KNOW..?

We want to be in the know!

If you have something to share, send it to Risha George. Include your **name, phone number** and send it to:

risha.george-1@nasa.gov
Flight Project Diversity and Inclusion Committee
Ext. 6-7433

Coming and Goings

March through August 2024

Comings

Chris Durachka (590) to 423/ Earth Science Data and Information System (ESDIS) Project

Patrick Hill (External) to 450/Exploration and Space Communications (ESC)

Michael Davis (599) to 443/James Webb Space Telescope (JWST)

Goings

Ken Schwer (430) Retirement

Carolyn Mariano (460) Retirement

Keith Chamberlin (460) Retirement

Dana Ostrenga (423) to 610

Rachid Chaoua (450) to 700

Anthony Nicoletti (401) Retirement

Paul Brandinger (420) Retirement

Chanel Duncan (460) to HQ

Bob Menrad (450) Retirement

Reassignments/ Realignments Details within Code 400

Patrick Kimviliakani (465) to 430.1/Mars Organic Molecule Analyzer-Mass Spectrometer (MOMA-MS)

Amanda Shelton (401) to 418/ Geostationary and Extended Orbit (GEO-XO) Flight

Paul Markie (401) to 418/ Geostationary and Extended Orbit (GEO-XO) Flight

Nick Chrissotimos (460) to 430/ Planetary Science Projects Division (PSPD)

Adam Matuszeski (435) to 431/ GSFC Dragonfly Payload

Chris Strickland (FPDP) to 460/ Explorers and Heliophysics Projects Division (EHPD)

Juli Lander (427) to 459/Advanced Communications Capabilities for Exploration and Science Systems (ACCESS)

Brandon Bethune (457) to 443/ James Webb Space Telescope (JWST)

Matt Magsamen (455) to 457/Near Space Network Project (NSN)

Jerry Mason (401.1) to 424/ Total and Spectral Solar Irradiance Sensor-2 (TSIS-2)

Neerav Shah (FPDP) to 437/Lunar Environment Monitoring Station (LEMS)

Stephanie Vidal (FPDP) to 436/Deep Atmosphere Venus Investigation of Noble gases, Chemistry and Imaging (DAVINCI)

Konrad Bergandy (FPDP) to 431/ GSFC Dragonfly Payload

Mark Voyton (427) to 460/Explorers and Heliophysics Projects Division (EHPD)

Jason Hair (425) to 473/Low Earth Orbit (LEO) Flight

Tony Cazeau (435) to 460/Explorers and Heliophysics Projects Division (EHPD)

Elizabeth Forsbacka (448) to 407/ Earth Science Technology Office (ESTO)

Karen Rogers / Code 400
Administrative Officer

THE CRITICAL PATH
A FLIGHT PROJECTS DIRECTORATE PUBLICATION 2024 FALL ISSUE

NASA's Hubble Sees Aftermath of Galaxy's Scrape with Milky Way

The Large Magellanic Cloud, also called the LMC, is one of the Milky Way galaxy's nearest neighbors. This dwarf galaxy looms large on the southern nighttime sky at 20 times the apparent diameter of the full Moon.

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