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Launching a new era in space telescopes

Arianespace's Ariane 5 rocket launches with NASA's James Webb Space Telescope onboard Dec. 25, from the ELA-3 Launch Zone of Europe's Spaceport at the Guiana Space Centre in Kourou, French Guiana. The James Webb Space Telescope (sometimes called JWST, or Webb) is a large infrared telescope with a 21.3 foot (6.5 meter) primary mirror. The observatory will study every phase of cosmic history — from within our solar system to the most distant observable galaxies in the early universe. *See page 2.*

NASA/Chris Gunn

Space telescope launched

Laura Betz
NASA Goddard Space Flight Center
and Natasha Pinol and Alise Fisher
NASA Headquarters

NASA's James Webb Space Telescope launched Dec. 25 on an Ariane 5 rocket from Europe's Spaceport in French Guiana, South America.

A joint effort with ESA (European Space Agency) and the Canadian Space Agency, the Webb observatory is NASA's revolutionary flagship mission to seek the light from the first galaxies in the early universe and to explore our own solar system, as well as planets orbiting other stars, called exoplanets.

"The James Webb Space Telescope represents the ambition that NASA and our partners maintain to propel us forward into the future," said NASA Administrator Bill Nelson. "The promise of Webb is not what we know we will discover; it's what we don't yet understand or can't yet fathom about our universe. I can't wait to see what it uncovers!"

Ground teams began receiving telemetry data from Webb about five minutes after launch. The Arianespace Ariane 5 rocket performed as expected, separating from the observatory 27 minutes into the flight. The observatory was released at an altitude of approximately 870 miles (1,400 kilometers). Approximately 30 minutes after launch, Webb unfolded its solar array, and mission managers confirmed that the solar array was providing power to the observatory. After solar array deployment, mission operators will establish a communications link with the observatory via the Malindi ground station in Kenya, and ground control at the Space Telescope Science Institute in Baltimore will send the first commands to the spacecraft.

NASA/Bill Ingalls

Launch teams monitor the countdown to the launch of Arianespace's Ariane 5 rocket carrying NASA's James Webb Space Telescope on Dec. 25 in the Jupiter Center at the Guiana Space Center in Kourou, French Guiana.

NASA/Desiree Stover

NASA technicians lifted the telescope using a crane and moved it inside a clean room at NASA's Goddard Space Flight Center in Greenbelt, Maryland, on April 13, 2017.

Engineers and ground controllers will conduct the first of three mid-course correction burns about 12 hours and 30 minutes after launch, firing Webb's thrusters to maneuver the spacecraft on an optimal trajectory toward its destination in orbit about 1 million miles from Earth.

"I want to congratulate the team on this incredible achievement – Webb's launch marks a significant moment not only for NASA, but for thousands of people worldwide who dedicated their time and talent to this mission over the years," said Thomas Zurbuchen, associate administrator for the Science Mission Directorate at NASA Headquarters in Washington. "Webb's scientific promise is now closer than it ever has been. We are poised on the edge of a truly exciting time of discovery, of things we've never before seen or imagined."

The world's largest and most complex space science observatory will now begin six months of commissioning in space. At the end of commissioning, Webb will deliver its first images. Webb carries four state-of-the-art science instruments with highly sensitive infrared detectors of unprecedented resolution. Webb will study infrared light from celestial objects with much greater clarity than ever before. The premier mission is the scientific successor to NASA's iconic Hubble and Spitzer space telescopes, built to complement and further the scientific discoveries of these and other missions.

"The launch of the Webb Space Telescope is a pivotal moment – this is just the beginning for the Webb mission," said Gregory L. Robinson, Webb's program director at NASA Headquarters. "Now we will watch Webb's highly anticipated and critical 29 days on the edge. When the spacecraft unfurls in space, Webb will undergo the most difficult and complex deployment sequence ever attempted in space. Once commissioning is complete, we will see awe-inspiring images that will capture our imagination."

The telescope's revolutionary technology will explore every phase of cosmic history – from within our solar system to the most distant observable galaxies in the early universe, to everything in between. Webb will reveal new and unexpected

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Governance process works

Cole reflects on her NASA career in flight research

Guest column

Jennifer Cole
NASA Armstrong deputy director for Programs and Projects (actng)

When I started a mere 20-ish years ago, the hallways of 4800 looked very different. The pale wallpaper was there, but from a personal standpoint, I was very often the only female engineer in the room. Although this wasn't a tremendous hurdle, I did wonder sometimes if I was supposed to be there. The common ground was a love for flight research, working for NASA and doing the absolute best job you could with integrity and excellence.

That common ground carries through to today, but I am relieved to no longer be the only female in the room. I'm extremely pleased to see more diversity of backgrounds, beliefs, lifestyles, and cultures represented at the NASA Armstrong. Work remains to be done, but I hope that trend continues as we will need that diversity of thought and inclusiveness of opinions to best address the Nation's biggest aerospace challenges.

AFRC2021-0076-0 **NASA/Lauren Hughes**

NASA Armstrong pilot Ted Williams, in a tan flight suit, watches as from left Lindsay Rodriguez, lead mechanic, provides cooling to the X-57 motors. Also pictured is Lyndel Lohberger, crew chief, in red.

One of the best successes at the center in the last few years is the implementation of the NASA Armstrong Governance process. For those of you unfamiliar with it, think of it as buy in and transparency in decision making, and communication of those decisions. After several attempts, I believe we have arrived at an approach that properly and appropriately involves line management and NASA Armstrong management and uses a process that can evolve with the center.

As a branch chief, it was always very important to me to understand what decisions were made and how to communicate them. The governance process does exactly this, which is in action at weekly meetings. I'm excited about this process and the pandemic has underscored not only its importance, but its effectiveness. Our ability to figure out how to safely get "back to work" after almost a full onsite shutdown was greatly enhanced because of the center's commitment to the governance process.

One of our modern challenges is cultivating home-grown research. Most of my time in the early days of my research career were charged to something called Flight Test Techniques. It was a discretionary fund held by the branch chiefs to seed interesting and compelling research ideas for work that wasn't directly supported by a project. The freedom for technical leaders to investigate early concepts quickly and easily using discretionary funding has diminished to almost nothing. How do we keep the organic research efforts alive, especially when projects budgets are already stretched so thin? It's been good to see the success of the NASA Armstrong Center Innovation Fund as well as the NASA Aeronautics Research Mission Directorate (ARMD) Convergent Aeronautics Solutions budget, but funding home-grown research remains a big challenge, especially for a research center.

Back in the early to mid-2000s, the center went through a downturn. The space shuttle Columbia accident had a big impact, and the research work also began to evaporate. We lost a lot of people, morale dropped, and the center's research interests weren't well-represented in the aeronautics side of the house. Sometime after, SOFIA made its way into the portfolio, and the center was able to carve out a very important role on Pad Abort 1, a flight test of the Orion launch abort system.

Today, we have a very robust portfolio of work from ARMD, the Science Mission Directorate, the Space Technology Mission Directorate, and reimbursable activities. This didn't happen overnight and was due in no small part to the perseverance of many at the center to insert ourselves into the leadership roles in NASA, mission directorate and project leadership levels and communicate the value of flight research to the agency and our stakeholders. More than 15 years later, this trend continues but we cannot give up. We finally have X-59 and a few more experimental airplanes on the horizon, plus large roles in transformative work like Advanced Air Mobility and electric propulsion. We cannot take these for granted.

NASA Armstrong staff are ambassadors for the center and play a very important role in the Nation's flight research capabilities. We understand the value of flight research and the unique role that the center and Edwards Air Force Base, and the surrounding community play in the U.S. aerospace sector and critical technology development. We may live and breathe flight research every day, but it might not be here tomorrow without our continued commitment to safety, excellence, teamwork, integrity, and inclusion.

Snapshots of 2021

NASA Armstrong proved its resilience in the face of a generational crisis to mark a number of achievements

By Teresa Whiting
NASA Armstrong Public Affairs

This year marks 75 years of flight research at NASA Armstrong and 2021 adds to those achievements. 2021 continued to be challenging while working in a mostly virtual environment, but progress was surely made.

NASA's next supersonic X-plane, the X-59, is taking shape for upcoming flights; NASA's first all-electric X-plane, the X-57, completed ground testing to prepare for flights; several Earth science missions were completed around the globe; and many other goals were met to prepare the center for a successful 2022 and beyond.

Armstrong Celebrates 75 Years

NASA Armstrong began celebrating its 75th anniversary Sept. 30, the day that 13 National Advisory Committee for Aeronautics employees established a unit here in 1946 to support the X-1 and the quest to break the sound barrier.

As part of the celebration, a time capsule prepared in 1996 was opened Oct. 13 and the capsule items were unloaded. NASA Administrator Bill Nelson, NASA Deputy Administrator Pam Melroy, NASA Armstrong Center Director David McBride, and Deputy Director Pat Stoliker reviewed the treasurers. Andy Blua and Don Whitfield, who helped build the time capsule and still work at the center, were invited to watch as the artifacts they helped safely store were unpacked.

X-59

The X-59 Quiet SuperSonic Technology accomplished major milestones in 2021 that gained national attention and positioned the Low-Boom Flight

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AFRC2021-0128-79 **NASA/Josh Fisher**

NASA Administrator Bill Nelson shows a picture of the X-3 to NASA Armstrong Center Director David McBride on Oct. 13. The X-3 photo was contained in a time capsule that was sealed on the center's 50th anniversary and opened to commemorate its 75th anniversary.

AFRC2021-0047-19-79 **NASA/Lauren Hughes**

NASA's all-electric X-57 Maxwell completed high-voltage ground testing with successful spinning of the propellers under electric power.

Lockheed Martin

The X-59 Quiet SuperSonic Technology (QueSST) aircraft takes shape at the Lockheed Martin Skunk Works facility in Palmdale.

AFRC2021-0047-19-79 NASA/Ken Ulbrich

Flight Research Inc.'s Bell OH-58C Kiowa helicopter hovers over a helipad after completing an urban air mobility approach at NASA Armstrong in March.

Stratodynamics Inc.

The uncrewed HiDRON stratospheric glider from Stratodynamics is designed to release from a sounding balloon at near-space altitude, enabling a controlled descent for technology payloads aboard.

AFRC2021-0096-03 NASA/Josh Fisher

NASA's Stratospheric Observatory for Infrared Astronomy, SOFIA, takes off from its base of operations at NASA Armstrong's Building 703 in Palmdale.

AFRC2021-0106-06 NASA/Josh Fisher

NASA's DC-8 taking off to St. Croix in support of the Convective Processes Experiment - Aerosols and Winds campaign (CPEX-AW) on Aug 17.

AFRC2021-0099-01 NASA/Carla Thomas

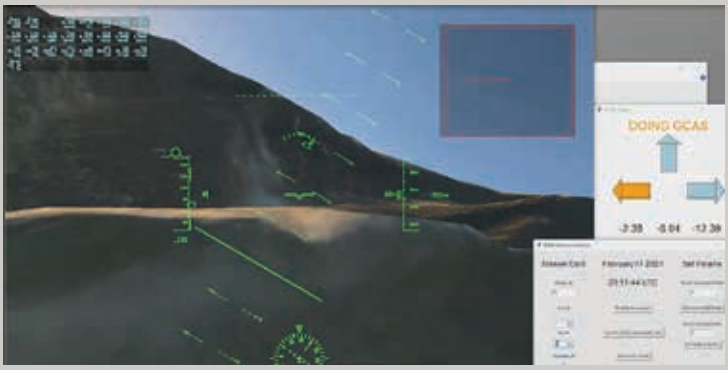
NASA Armstrong flies the C-20 aircraft in support of the Advanced Synthetic Aperture Radar (ASAR) campaign on July 22.

AFRC2021-0079-17 NASA/Carla Thomas

NASA Armstrong's ER-2 No. 809 high-altitude aircraft takes off for the Dynamics and Chemistry of the Summer Stratosphere science flights in Palmdale on June 17.

AFRC2021-0059-02 NASA/Lauren Hughes

A flight crew prepares the B200 King Air for the Sub-Mesoscale Ocean Dynamics Experiment at NASA Armstrong. From left to right are Jeroen Molemaker and Scott "Jelly" Howe.



NASA/Mark Skoog

This screenshot taken from the Common Integration Tool (CIT) simulator shows an element of the Expandable Variable Autonomy Architecture software system working called Automatic improved Ground Collision Avoidance System or Auto iGCAS. This software has the potential to save aircraft ranging from general aviation to future autonomous aircraft.

AFRC2021-0145-35 NASA/Josh Fisher

NASA Armstrong's Flight Loads Laboratory is working on one of its biggest load calibrations tests on an F/A-18E Super Hornet from the Naval Air Systems Command in Patuxent River, Maryland.

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Demonstration mission for a promising 2022. As the X-59 took shape in 2021, teams at NASA Armstrong prepared the X-plane's future hangar, while hardware and techniques for the X-plane's future acoustic validation research were advanced inflight.

A contract was also awarded to handle the cutting-edge ground recording system that will measure the unique quiet thumps heard on the ground as the X-59 passes at supersonic speeds overhead. The aircraft, overcoming great challenges related to the pandemic, completed its initial assembly, and was shipped to Fort Worth, Texas for its first ground tests.

X-57

High-voltage ground testing took place on NASA's first all-electric X-plane, the X-57 Maxwell. The X-57, which is in its first configuration called Mod II, drew power from a large, off-aircraft high-voltage power supply for these tests at NASA Armstrong. A highlight from high-voltage testing included the spinning of the propellers for the first time under electric power. Though the propellers had previously spun during the X-57's initial build phase conducted by the small business prime contractor Empirical Systems Aerospace, Inc. at Scaled Composites in Mojave, it is now up to NASA engineers to advance the system and use lessons learned from previous tests. The X-57 team continues to prepare the aircraft for the first flight in the Mod II configuration in the spring.

Advanced Air Mobility National Campaign

NASA's Advanced Air Mobility National Campaign crossed through several barriers this year in the pursuit of integrating electric vertical takeoff and landing or eVTOL aircraft into the National Airspace System or NAS. The team opened solicitations for new industry partners to join the National Campaign and completed signings.

Joby's eVTOL was flown in several flight scenarios including flights to test the noise of the aircraft. The team also flew an OH-58 helicopter like a surrogate urban air mobility vehicle to prepare for the Joby flight and others. Projects and sub-projects under the Advanced Air Mobility Mission are all working towards the common goal of researching what it will take to integrate these vehicles into the NAS.

Flight Opportunities

Video capture during future lunar landings could play an important role in contributing to researchers' understanding of disturbances in lunar surface materials – called regolith – caused by the lander's rocket plume. The desert environment of Mojave, California, provided a stand-in for the surface of the Moon, and the Xodiac vertical takeoff vertical landing (VTVL) platform from Masten Space Systems was the test vehicle.

Another highlight for Flight Opportunities took place between June 1 and 6 when Stratodynamics Inc. of Lewes, Delaware, launched its HiDRON stratospheric glider from a high-altitude balloon at Spaceport America in New Mexico carrying technology supported by NASA's Flight Opportunities program for the first time.

Stratospheric Observatory for Infrared Astronomy (SOFIA)

In July, NASA's Stratospheric Observatory for Infrared

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SARP students experience NASA research first hand

By Elena Johnson
NASA Armstrong Public Affairs

After a year delay due to the COVID-19 pandemic, 53 students flew on NASA's DC-8 as part of NASA's Student Airborne Research Project (SARP).

Now in its thirteenth year, SARP offers opportunities to undergraduate students from various universities across the United States who are majoring in sciences, mathematics, and engineering to participate in a NASA research campaign.

NASA's DC-8 airborne research laboratory flew over California's Inland Empire, Imperial Valley and San Joaquin Valley to conduct research on air pollution with low-level flights beginning on Dec. 6 at NASA Armstrong's Building 703 in Palmdale.

Participants flying on board were assisting scientists in the operation of instruments that measure air pollution and greenhouse gases to better understand their sources and how they react in the atmosphere. In addition, the scientists and students will be comparing their data to air quality forecasts and satellite observations after the conclusion of flights on Dec. 10.

SARP provides students with hands-on research experience in all aspects of a major scientific campaign, from detailed planning on how to achieve mission objectives to formal presentation of results and conclusions to peers and others.

AFRC2021-0099-01 **NASA/Carla Thomas**

NASA Student Airborne Research Program students, mentors and faculty pose in front of NASA's DC-8 on Dec. 7 at NASA Armstrong's Building 703. ***Below****, NASA's DC-8 flew for the NASA Student Airborne Research Project to measure aerosols with the Langley Aerosol Research Group Experiment instrument with the Cavity Attenuated Phase Shift PMex Monitor (Particle Optical Extinction).*

"For many of these students, it is their first time being able to conduct scientific research" says SARP Program Manager Dr. Brenna Biggs. "SARP is a great opportunity to train the next generation of scientists, especially those who are interested in atmospheric sciences."

Students participating in this year's program were competitively selected based on their academic performance, future career plans, and interest in Earth science. All the SARP participants are fully vaccinated and followed standard COVID-19 protocols. For students interested in participating in SARP 2022, the application is open until Jan. 26. The application is at: https://baeri.formstack.com/forms/sarp_2022

AFRC2021-0099-42
NASA/Carla Thomas

SARP is managed by NASA's Ames Research Center in California's Silicon Valley through the National Suborbital Research Center at the Bay Area Environmental Research Institute with funding and support from NASA's Earth Science Division. NASA Armstrong manages and maintains NASA's DC-8.

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discoveries and help humanity understand the origins of the universe and our place in it.

NASA Headquarters oversees the mission for the agency's Science Mission Directorate. NASA's Goddard Space Flight Center in Greenbelt, Maryland, manages Webb for the agency and oversees work on the mission performed by the Space Telescope Science Institute, Northrop Grumman, and other mission partners. In addition to Goddard, several NASA centers contributed to the project, including the agency's Johnson Space Center in Houston, Jet Propulsion Laboratory in Southern California, Marshall Space Flight Center in Huntsville, Alabama, Ames Research Center in California's Silicon Valley, and others.

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Astronomy deployed to Tahiti, French Polynesia to study celestial objects best observed from the Southern Hemisphere. The team completed 13 successful flights before returning early due to updated COVID-19 precautions.

For the first time since 2008, SOFIA's upper rigid door was removed during its annual maintenance period. The upper rigid door is one of the key aspects of SOFIA that allows the observatory to operate. As the largest airborne observatory in the world, SOFIA allows scientists to study observations that are not visible from telescopes on the ground.

DC-8

In August, NASA's DC-8 deployed to St. Croix in the U.S. Virgin Islands after more than six months of maintenance. The DC-8 flew in support of the Convective Processes Experiment – Aerosols and Winds campaign, CPEX-AW, which aims to gather critical data about tropical convection processes. The DC-8 flying laboratory is used to collect data for experiments in support of projects that serve the world's scientific community.

C-20A

The C-20A flew various science flights using the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) to gather data on the Earth's surface. Beginning in August, the C-20 flew in support of the Delta-X campaign to gather data on deltas and wetlands. The C-20A aircraft provides long-term capability to efficiently conduct airborne environmental science missions.

ER-2 High Altitude Aircraft

One of NASA's ER-2s, deployed to Salina, Kansas for the Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) project to study intense summer thunderstorms over the central United States. The ER-2 flew as high as 70,000 feet to collect atmospheric chemistry samples to understand how dynamic and chemical processes interact and how that composition may change in response to ongoing changes in the climate system.

Both of NASA's ER-2 aircraft are used in support of Earth science missions to fly at high-altitudes into the lower stratosphere.

B-200 King Air

In May, the B-200 King Air flew in support of the Sub-Mesoscale Ocean Dynamics Experiment (S-MODE) mission to study the role of small-scale whirlpools and ocean currents in climate change before beginning the full-fledged campaign in October. A total of 12 successful flights were performed in support of S-MODE during the October campaign.

Resilient Autonomy

Resilient Autonomy ended in September, but accomplished several goals in 2021. The team worked with the Federal Aviation Administration (FAA) and the U.S. Department of Defense (DoD), to create new autonomous aircraft technology called EVAA or Expandable Variable Autonomy Architecture.

EVAA could help prevent accidents in retrofit general aviation aircraft and future autonomous aircraft. The DoD, the FAA and other groups such as the Alaska bush pilot community are looking into how this software could be integrated into a variety of aircraft. The EVAA software is now managed under the NASA Armstrong Center Technology Transfer office.

Flight Loads Lab F/A-18E tests

NASA Armstrong's Flight Loads Laboratory is working on one of its biggest load calibrations tests on an F/A-18E Super Hornet from the Naval Air Systems Command (NAVAIR) in Patuxent River, Maryland. This testing is needed before the aircraft can serve as a test vehicle for determining its ability to safely manage maneuvers and proposed upgrades. The horizontal tail testing, the first of three phases, wrapped up in October. The next phase focuses on wing loads testing.

NASA STEM

Most of NASA Armstrong's Office of STEM Engagement activities took place in a virtual environment in 2021, but the activities still made large impacts. Through the Minority University Research and Education Project's Institutional Research Opportunity (MIRO), students attending Minority Serving Institutions (MSIs) studied the potential space applications of carbon nanotubes.

Three interns funded through a Space Grant worked on Armstrong projects such as Preliminary Research Aerodynamic Design to Land on Mars (Prandtl-M) and the Revolutionary Vertical Lift Technology (RVLT) project. One Armstrong intern team even worked on the Greater Heights Project – a virtual reality experience allowing people to "fly" the X-15 rocket plane. Armstrong's Office of STEM Engagement continually collaborates with the regional STEM community to support education programs that are designed to foster the growth of a diverse STEM workforce.

The X-Press is published the first Friday of each month for civil servants, contractors and retirees of the NASA Armstrong Flight Research Center.

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