

THE ARMSTRONG XPRESS

Volume 63 Number 8 July 2021

NASA mission explores intense summer storms



AFRC2021-0079-17

NASA/Carla Thomas

NASA Armstrong's ER-2 No. 809 high-altitude aircraft heads for the Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) science flights in Palmdale on June 17. See story, page 2.

DCOTTS mission readied

ER-2 will study convective impacts of thunderstorms

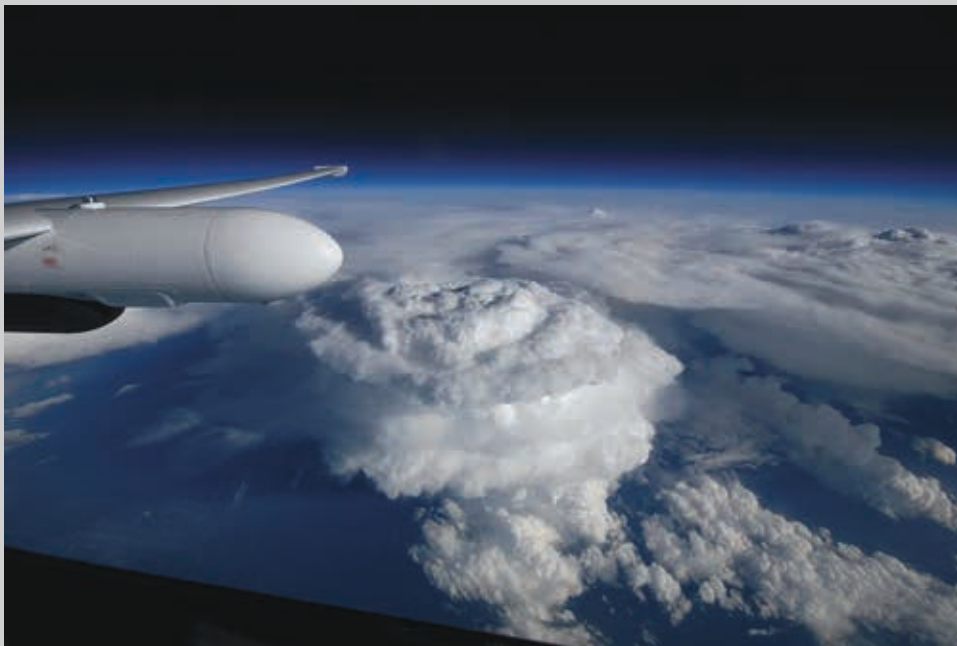
Elena Johnson

NASA Armstrong Public Affairs

NASA and university scientists will be studying the intense summer thunderstorms over the central United States to understand their effects on Earth's atmosphere and how it contributes to climate change.

As part of NASA's Earth Science Division, the Dynamics and Chemistry of the Summer Stratosphere, or DCOTSS, project will be flying out of Salina, Kansas during the summers of 2021 and 2022. The project will directly study the convective impacts of thunderstorms over North America.

The DCOTSS mission aims to understand how dynamic and chemical processes interact to determine the composition of the stratosphere, and how that composition may change in response to ongoing changes in the climate system.



NASA Armstrong's ER-2 aircraft flies above an overshooting storm during a previous mission.

NASA/Stu Broce

After a one-year delay due to the COVID-19 pandemic, DCOTSS science flights are set to launch on July 16. NASA's Armstrong's ER-2 aircraft will fly as high as 70,000 feet to collect

atmospheric chemistry samples to better understand material transported to the stratosphere by convective storms. Referred to as overshooting storms, rising air, particles and chemicals in

these intense thunderstorms can be carried high above the lowest layer of the atmosphere into the stratosphere, which most

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AFRC2021-0079-05

NASA/Carla Thomas

NASA Armstrong ER-2 pilot Gary Toroni and engineering technician Raul "Corky" Cortes are preparing life support for Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) science flights in Palmdale on June 17.

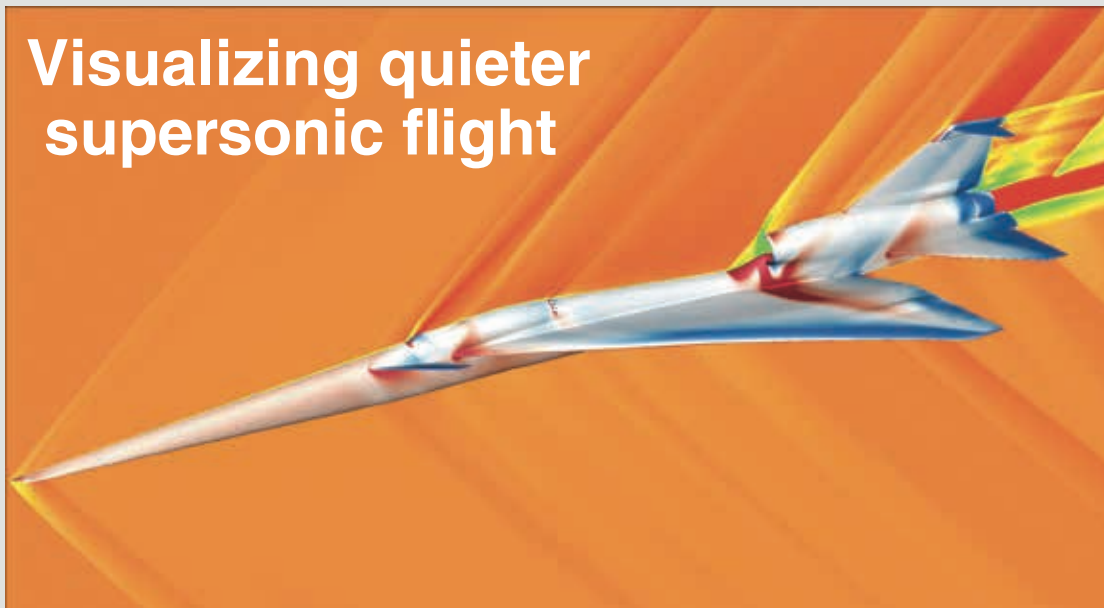


AFRC2021-0079-09

NASA/Carla Thomas

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

Visualizing quieter supersonic flight



NASA/James C. Jensen

NASA's X-59 Quiet SuperSonic Technology X-plane is designed to fly faster than the speed of sound without producing sonic booms – those loud, startling noises which can be disruptive to humans and animals. Currently, commercial aircraft aren't allowed to fly faster than the speed of sound over land because of the objectionable sonic booms they cause for those on the ground. This experimental plane will fly at a cruise speed roughly double that of a commercial jet while keeping aircraft noise down to a quiet "sonic thump" – or even no sound at all – as heard on the ground when the plane flies overhead at supersonic speeds.

To be sure the X-59's design will perform within expected noise limits, NASA is working closely with its contractor, Lockheed Martin, to create a database of computational fluid dynamics simulations to verify the aircraft's supersonic performance. The database will include simulations for all possible combinations of the settings that a pilot uses to control the aircraft and the flight conditions that may be encountered during flight.

News at NASA

Mars Rover to acquire first sample

NASA is making final preparations for its Perseverance Mars rover to collect its first-ever sample of Martian rock, which future planned missions will transport to Earth. The six-wheeled geologist is searching for a scientifically interesting target in a part of Jezero Crater called the "Cratered Floor Fractured Rough."

This important mission milestone is expected to begin within the next two weeks. Perseverance landed in Jezero Crater Feb. 18, and NASA kicked off the rover science phase June 1.

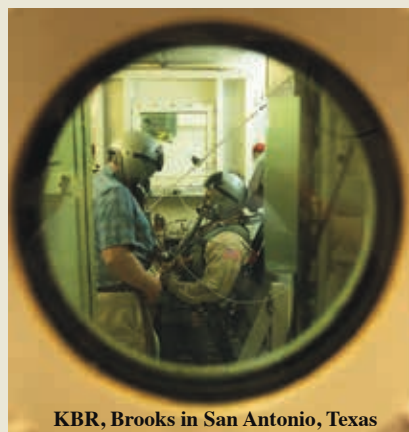
Here's a look inside the X-59 test chamber

Kristen Hatfield

NASA Langley Public Affairs

Safety is paramount for NASA's quiet supersonic flight team and it is making great strides in preparing for future flight testing with the X-59 Quiet SuperSonic Technology (QueSST) aircraft. To achieve the safest possible environment and aircraft for pilots, NASA is working with contractor KBR and relying on its expertise to make sure that the aircraft is meeting required standards for the life support and emergency oxygen systems.

NASA's X-59 is a research aircraft designed to take the "boom" out of the sonic boom with its quiet supersonic technologies and design features. The Low-Boom Flight Demonstration mission is reshaping supersonic flight by helping to change



KBR, Brooks in San Antonio, Texas



KBR, Brooks in San Antonio, Texas

At left is the low pressure chamber at KBR's facility in San Antonio, Texas, which simulates very high altitudes by reducing the air pressure inside of the chamber. The subject inside the chamber experiences the reduced pressure conditions that exist at higher altitudes. At right a military test volunteer wears protective equipment, while breathing oxygen before undergoing a rapid decompression. The goal of the test is to verify the equipment that he uses and wears, as well as the life support system, all work properly.

the existing aviation rules by collecting community feedback on the gentle thump that they hear when the X-59 flies overhead. This data will then be shared with federal and international regulators to enable them to consider setting new guidelines for supersonic travel over land. To get to this phase of the project, the team

Test chamber page 8

S-MODE underway

Small-scale whirlpools, ocean currents studied

By Sofie Bates

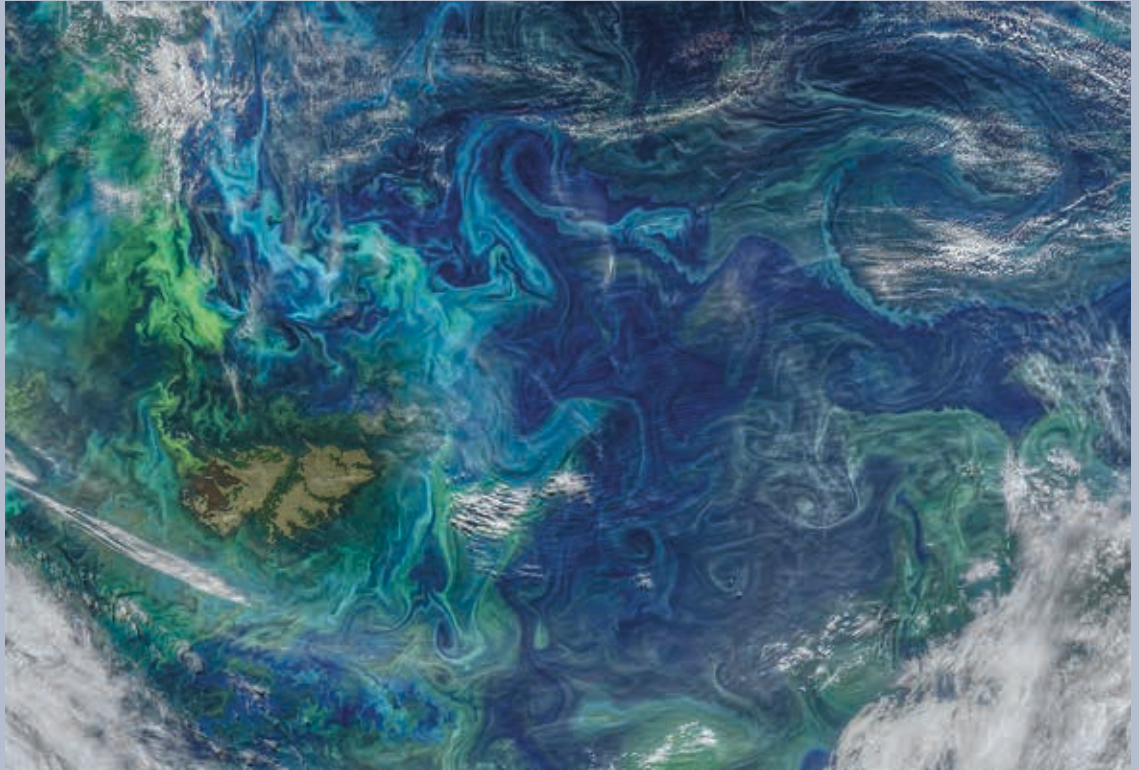
NASA's Earth Science news team

After being delayed over a year due to the pandemic, a NASA field campaign to study the role of small-scale whirlpools and ocean currents in climate change happened in May.

Using scientific instruments aboard a self-propelled ocean glider and several airplanes, this first deployment of the Sub-Mesoscale Ocean Dynamics Experiment (S-MODE) mission deployed its suite of water- and air-borne instruments to ensure that they work together to show what's happening just below the ocean's surface. The full-fledged field campaign will begin in October 2021.

"The May campaign was largely to compare different ways of measuring ocean surface currents so that we can have confidence in those measurements when we get to the pilot in October," said Tom Farrar, associate scientist at the Woods Hole Oceanographic Institution in Massachusetts and principal investigator for S-MODE.

The S-MODE team hopes to learn more about small-scale movements of ocean water such as eddies. These whirlpools span about 6.2 miles or ten kilometers, slowly moving ocean water in a swirling pattern. Scientists think that these eddies play an important role in moving heat from the surface to the ocean layers below, and vice versa. In addition, the eddies may play a role in the exchange of heat, gases and nutrients between the ocean and Earth's atmosphere. Understanding these small-



NASA's Goddard Space Flight Center Ocean Color, using data from the NOAA-20 satellite and the joint NASA-NOAA Suomi NPP satellite.

Sub-mesoscale ocean dynamics, like eddies and small currents, are responsible for the swirling pattern of these phytoplankton blooms (shown in green and light blue) in the South Atlantic Ocean on Jan. 5.



AFRC2021-0059-02

NASA/Lauren Hughes

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

scale eddies will help scientists better understand how Earth's oceans slow down global climate change.

A self-powered surfboard, for science

The team is using a self-propelled commercial Wave Glider decked out with scientific instruments that can study the ocean from its surface. The most important gadgets aboard are the acoustic Doppler current profilers, which use sonar to measure water speed and gather information about how fast the currents and eddies are moving, and in which direction. The glider also carries instruments to measure wind speed, air temperature and humidity, water temperature and salinity, and light and infrared radiation from the Sun.

“The wave glider looks like a surfboard with a big venetian blind under it,” said Farrar.

That “venetian blind” is submerged under the water, moving up and down with the ocean's waves to propel the glider forward at about one mile per hour. In this way, the wave glider deployed from La Jolla, California, collected data as it traveled over 62 miles (100 kilometers) out into the ocean offshore of Santa Catalina Island.

The new data allow the scientists to estimate the exchange of heat and gases between Earth's atmosphere and the ocean, and consequently better understand global climate change.

“We know the atmosphere is heating up. We know the winds are speeding up. But we don't really understand where all that energy is going,” said Ernesto Rodriguez, research fellow at NASA's Jet Propulsion Laboratory in Pasadena, California, and deputy principal investigator for the airborne parts of S-MODE. It's likely that this energy is going into the ocean, but the details of how that



AFRC2021-0059-33

NASA/Carla Thomas

Flight crews at NASA Armstrong flew the Sub-Mesoscale Ocean Dynamics Experiment (S-MODE) installed in the B200 King Air on May 3.



AFRC2021-0059-25

NASA/Lauren Hughes

Delphine Hypolite, Multiscale Observing System of the Ocean Surface (MOSES) Operator from the University of California, Los Angeles, performs pre-flight checks on the MOSES Camera System at NASA Armstrong.

process works are still unknown. The team thinks that small-scale eddies may help move heat from the atmosphere to the deeper layers of the ocean.

Eyes and scientific instruments in the skies

While the Wave Glider continued its slow trek across the ocean's surface, several airplanes flew overhead to collect data from a different vantage.

“In an airplane, we can get a snapshot of a large area to see the context of how the bigger- and

smaller-scale ocean movements interact,” said Rodriguez.

For example, a ship or wave glider travels slowly along a straight line, taking precise measurements of sea surface temperature at specific times and places. Airplanes move faster and can cover more ground, measuring the sea surface temperature of a large swath of ocean very quickly.

“It's like taking an infrared image rather than using a thermometer,” explained Farrar.

Two planes were used in the May test flights: a B200 plane from NASA Armstrong, and a commercial plane from Twin Otter International. The B200 carried an instrument from NASA JPL called DopplerScatt to measure currents and winds near the ocean surface with radar. The Multiscale Observing System of the Ocean Surface (MOSES) instrument from the University of California, Los Angeles, was also

By Nicole Quenelle
Fuentek

In a series of flights between June 1 and 6 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. Flying aboard were technologies developed by the University of Kentucky in Lexington and NASA's Langley Research Center in Hampton, Virginia, that aim to help researchers improve turbulence detection capabilities.

The Flight Opportunities program is funded by NASA's Space Technology Mission Directorate (STMD) and managed at NASA Armstrong. NASA's Ames Research Center in California's Silicon Valley manages the solicitation and evaluation of technologies to be tested and demonstrated on commercial flight vehicles.

"Currently, commercial aviation relies on meteorology and pilot reporting to predict and communicate areas of turbulence that other piloted aircraft might encounter," said Sean Bailey, principal investigator for a wind probe from the University of Kentucky. "So, we hope to fill gaps in currently available methods of turbulence detection, which should benefit unpiloted drones, low-Earth orbit spacecraft, and aviation overall."

The series of flights aimed to help researchers assess the performance of both the wind probe and an infrasonic microphone sensor, developed by researchers at Langley, including co-Investigator Qamar Shams, and which Stratodynamics licensed from NASA in 2020. Together, the instruments are designed to aid turbulence detection for remote-piloted and autonomous aerial vehicles, including commercial



HiDRON

Glider supports its first Flight Opportunities payload

Stratodynamics, Inc./UAVOS

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. The glider also achieves higher velocity than a balloon flight alone – one of the reasons NASA-supported researchers from the University of Kentucky chose Stratodynamics as the flight provider for testing of turbulence detection instruments.



Stratodynamics, Inc./UAVOS

The HiDRON stratospheric glider from Stratodynamics is seen over New Mexico on June 6, carrying turbulence detection technologies supported by NASA's Flight Opportunities program.

aircraft and on-demand delivery drones.

While the company has conducted pre-flight testing with the licensed sensor, the recent flights were a culminating flight campaign, enabling cross validation of the sensor with

the university's wind probe. The HiDRON glider enabled the instruments to capture wind velocity, direction, magnitude, and low-frequency sound waves in a flight environment not possible with conventional balloon-borne wind

measurements.

"The advantages of using this type of aircraft – a balloon launch with a glider recovery – has a lot to do with the conditions needed to test our

HiDRON page 7

DCOTSS... from page 2

thunderstorms do not usually reach.

The ER-2 provides sampling opportunities at a higher altitude range than other platforms. There will be 12 instruments on the ER-2 to measure gases and particles carried into the stratosphere by intense thunderstorms. During the campaign, the scientists will be collecting and analyzing this data to understand the effects of overshooting storms on Earth's atmosphere.

"This is the first mission that is specifically designed to look at the impacts of overshooting storms," said Dr. Kenneth Bowman, DCOTSS principal investigator and a professor of atmospheric science at Texas

A&M University.

"Approximately 50,000 storms occur over the U.S. during a typical summer, so almost every day, somewhere in the US, overshooting storms are happening," he explained. "There are many scientific questions about the effects of these storms on the stratosphere that we will be able to address with data from DCOTSS. These include the processes operating at the tops of these intense storms, the potential effects of manmade chemicals on the stratospheric ozone layer, and the sources and composition of aerosol particles in the stratosphere."

According to Dr. Bowman, in the last 10 years much has been learned about thunderstorms

from other observing systems such as radars and satellites. These systems have revealed that overshooting storms happen more often than scientists originally thought. In addition to potentially affecting the ozone layer, overshooting storms also eject water vapor into the stratosphere. Water vapor is a potent greenhouse gas that contributes to global warming.

Because overshooting thunderstorms are most common over the central U.S., Salina, Kansas is considered an ideal base of operations for the ER-2 flights. The ER-2 will fly as close as 50 kilometers downwind from the overshooting storms to collect data safely and accurately.

As part of this campaign,

several series of flights are scheduled. These consist of a five-week test flight period, and two seven-week science deployments from Salina. As part of the series of test flights, the ER-2 flew from NASA Armstrong's Building 703 in Palmdale in June that ensured the aircraft and instruments operated properly. It also collected data in places thunderstorms do not normally occur.

Measurements from the California flights will be significantly different from the ones taken during the summer campaign and will provide a useful comparison to the measurements of the gases and particles obtained over the Midwest.

S-MODE... from page 5

aboard to collect sea surface temperature data. On the Twin Otter plane was the Modular Aerial Sensing System (MASS) from the Scripps Institution of Oceanography at the University of California, San Diego, which is an instrument capable of measuring the height of waves on the surface of the ocean.

The fleet will gain a third

member for the October experiments: NASA's Langley Research Center Gulfstream III plane with JPL's Portable Remote Imaging SpectroMeter, an instrument to measure phytoplankton and other biological material in the water. The October deployments will also use a large ship and some autonomous sailing vessels,

called Saildrones, in addition to planes and Wave Gliders.

After nearly a year and a half of delays due to the pandemic, the S-MODE team is excited to get their planes in the sky and the gliders in the water. "It was frustrating," Rodriguez said, "but the science team hasn't slowed down. The science keeps progressing."

S-MODE is NASA's ocean physics Earth Venture Suborbital-3 mission, funded by the Earth System Science Pathfinder Program Office at NASA's Langley Research Center in Hampton, Virginia, and managed by the Earth Science Project Office at NASA's Ames Research Center in Mountain View, California.

HiDRON... from page 6

instruments," said Sean Bailey, principal investigator for the innovation at the University of Kentucky. "The sensitivity of the sensor actually increases with increasing velocity. So, it's not something you could get to work on a conventional balloon because the air flow wouldn't be fast enough."

Bailey explained that the glider's velocity – which reached a top speed of more than 300 miles per hour – enabled the instruments to pick up small, subtle changes induced by turbulent fluctuations. The glider was released at an altitude

of 25 km on the first two flights, and at 30 km on the final flight with successful gliding at 28 km. The wind probe and sensor remained fully operational for the duration of each flight and researchers will process the resulting data to validate the technology's performance over the next few months.

The university selected Stratodynamics as the flight provider as part of a proposal for funding under NASA's Tech Flights solicitation. Open to U.S.-based industry, academia, and other non-NASA government organizations, the solicitation

provides awardees a grant or collaborative agreement allowing them to purchase flights directly from the U.S. commercial flight provider that best meets their needs.

"The Tech Flights solicitation has brought to the forefront new and innovative flight providers," said John Kelly, program manager for Flight Opportunities. "With each new available flight profile – such as this hybrid, high-altitude approach – researchers supported by the program have an even broader range of relevant flight environments available for testing."

"Stratodynamics is proud to be collaborating with NASA and participating in the pioneering framework that the Flight Opportunities program provides," said Nick Craine, the company's business development lead. "The program enables us to offer our energy-efficient aerial platforms and high-altitude expertise to more collaborators such as the University of Kentucky, advance new technologies and research, and provide cost-effective access to the stratosphere at a fraction of the cost of piloted scientific aircraft."

NASA's National Campaign adds partners

Teresa Whiting

NASA Armstrong Public Affairs

Thirteen companies and one university have signed agreements with NASA's Advanced Air Mobility project's National Campaign to continue work towards integrating air taxis, cargo delivery aircraft and other new air vehicle concepts into the national airspace system.

The partners will participate in NC-1 by flying their innovative vehicles, developing future airspace system capabilities, or providing key infrastructure related capabilities. NC-1 will include flight demonstrations and simulations at test sites around the country over several months. The following industry partners were chosen:

Flight partners for demonstrations: Reliable Robotics Corporation and continued work with Wisk Aero LLC and Joby Aviation.

Infrastructure partners for demonstrations: AURA Network Systems, Raytheon Company, Robust Analytics Inc., SkyGrid, and The University of North Texas. AURA was also chosen for additional communications, navigation, and surveillance flight testing activities.



NASA illustration

Airspace partners for simulations: ANRA Technologies Inc., ARINC Incorporated, Avison Inc., Metron Aviation Inc., OneSky Systems Inc., SkyGrid, and Unmanned Experts Inc.

These partners have signed on for the first full phase of testing for the National Campaign, or NC-1, which is planned for 2022. This includes flight, airspace, and infrastructure partners for flight testing.

“The National Campaign team is excited to conduct operational flight demonstrations with the first Advanced Air Mobility integrated experimental ecosystem for the urban environment that connects airspace providers, infrastructure services, and a UAM vehicle in real time,” said Starr Ginn, AAM National Campaign lead.

These partners were chosen for a non-reimbursable Space Act Agreement to work alongside NASA in a mutually beneficial opportunity.

After solicitations opened in February, several local governments across the U.S. also signed agreements in May to help accelerate Advanced Air Mobility. Additional partnerships are anticipated with industry in support of NASA's Advanced Air Mobility initiatives.

NASA's vision for Advanced Air Mobility is to help create safe, sustainable, accessible, and affordable aviation for several uses at the local and regional level.

Test chamber... from page 3

needs to ensure that the X-59's life support system is effective in providing the protection needed to enable flight at the required high altitudes.

To ensure the X-59 pilot's safety, the sophisticated life support system equipment is undergoing a series of tests that include simulating an unlikely cabin depressurization.

Military test volunteers are constantly monitored by a team

of experts as a live stream of this activity and its data are displayed on monitors. The physiology of the test volunteers is also tracked, and there is a medical professional on-site in the unlikely event one is needed.

Rapid decompression testing up to either 50,000 or 60,000 feet in the air makes sure the pilot can survive a sudden loss of pressure at the X-59's cruising altitude by providing oxygen under high

pressure to the pilot's lungs – to prevent damage to the lungs, the volunteer and pilot must wear a counter-pressure vest and pants. This altitude is more than 20,000 feet higher than the altitude at which commercial airplanes fly. Typically, commercial airline flight passengers experience pressure at altitudes of up to only 8,000 feet. As part of this test, the test volunteer descends back down to ground level at pre-

determined rates. Continuous monitoring by the test team ensures proper function of the protective equipment as well as the volunteer's health and safety.

The primary oxygen system testing is now complete, with testing to follow on the X-59's emergency oxygen system. After completion, the systems will be placed on the X-59 and the team will administer additional checkouts after installation.

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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