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Smooth flow

AFRC2016-0364-11 NASA/Carla Thomas

Above, *NASA's F-15 research test bed will expose the Swept Wing Laminar Flow test article to speeds up to Mach 2, matching conditions presented during wind tunnel testing at NASA's Langley Research Center.*

At right*, The Swept Wing Laminar Flow test article, integrated to the underside of a NASA F-15, will examine the effectiveness of different configurations of small dots, called distributed roughness elements, to extend smooth, laminar airflow over a wing's depth, reducing friction drag.*

AFRC2017-0037-01 NASA/Ken Ulbrich

Research begins on laminar flow concept

By Matt Kamlet
Armstrong Public Affairs

NASA is set to begin a series of supersonic flights that will examine efforts to improve the efficiency of future supersonic aircraft.

The flights, which are expected to begin in April from NASA Armstrong, will follow developments identified by high-speed wind tunnel testing conducted at NASA's Langley Research Center in Virginia.

As NASA proceeds toward the possible development of a proposed Low-Boom Flight Demonstration aircraft, or LBFD, research done by the agency's Commercial Supersonic Technology project, or CST, continues to investigate ways to mitigate or minimize the disruptive sonic boom associated with supersonic flight, as well as approaches to overcome other technical barriers to innovation in commercial supersonic flight.

One such barrier is fuel efficiency. At supersonic speeds, the force of

Flow, page 12

ADATS moves huge data sets fast

By Jay Levine
X-Press editor

A network and communication architecture that can more efficiently move data from research aircraft, while using half the bandwidth of traditional methods, could eventually enable data collection of precise measurements needed for testing the next generation of X-planes.

Called the Advanced Data Acquisition and Telemetry System, or ADATS, researchers at NASA Armstrong Flight Research Center in California integrated the new systems into a NASA King Air recently for a series of three flights following extensive ground testing. The new system can move 40 megabits per second, which is the equivalent of streaming eight high-definition movies from an online service each second, said Otto Schnarr, principal investigator.

Researchers aren't looking to make binge watching easier – they are interested in the system's speed in moving large amounts of data up to four times faster than previous network-based telemetry efforts and up to 10 times faster than current systems Armstrong researchers are using, Schnarr explained.

All of this capability is gained without new architecture and using the advanced modulation technique to save spectral bandwidth, time and research dollars, said electrical engineer Matthew Waldersen. In addition, the system allows people to participate in the flight test from wherever a secure network is available. As many as 3.3 million sensor measurements per second can be acquired, or a focused data set can be targeted to free up bandwidth for other tasks, like streaming high-definition video simultaneously, he added.

ADATS aims to advance flight test data acquisition and telemetry systems using an Ethernet via telemetry subsystem that wirelessly transmits test data and an advanced data acquisition system that allows remote researchers to command experiments and receive data collection during flight.

EC98-44816-4 NASA/Lori Losey

A NASA King Air successfully tested the Advanced Data Acquisition and Telemetry System during a recent series of three research flights.

AFRC2017-0021-04 NASA/Ken Ulbrich

Otto Schnarr, front, and Matthew Waldersen check out the Advanced Data Acquisition and Telemetry System in an Armstrong laboratory.

"The main components are a ground station, a transceiver on the airplane and the instrumentation systems that tie everything together," said Tom Horn, ADATS project manager. "The tests explored what this system does and how it behaves. We wanted to make sure we understood the nuances and determine if additional testing is required for researchers to feel comfortable using it."

The flights capped a three-year effort to fill in existing gaps in the technology, such as range, instrumentation and system design challenges. ADATS team members have made well-received presentations at the center that led to additional brainstorming sessions on potential uses for the technology.

"People were not having trouble coming up with how they could put it to use," Waldersen explained. "Having more data allows researchers to do what they do better. Everyone at the sessions agreed the technology is worth pursuing. You know a project is a success when you take questions from engineers like, 'have you considered using it for this case, or could we do this with it?'"

Building up the capability is the next step.

"In any electronics project there is a hardware and a software component," Waldersen said. "We have completed a lot of work with the hardware component to see what it can do and now it's a matter of the software aspect and how it integrates with ground operations, which projects will put it to use immediately and what other systems can we build around it to fully utilize the capability."

Maturing the technology could be useful for upcoming X-plane testing. For example, measurements of airflow data along the entire face of a fan engine could be efficiently researched, Horn explained. Another advantage is unlike traditional data collection that can experience loss of data, or "dropouts," ADATS can eliminate the loss with this data collection method. However, delays can still occur and researchers are looking into understanding the ramifications of that for safety.

In addition, the system also could have implications for uninhabited air vehicles and systems for uplinks and bandwidth management. For example, aircraft like the Ikhana or Global Hawk could gain efficiencies. ADATS also could work in combination with an Ethernet-based fiber optic sensing system to streamline data collection.

The ADATS effort can be traced

ADATS, page 11

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Armstrong receives plaque

NASA Armstrong Center Director David McBride and Dana Askins, Human Resources and Management and Development officer, display the center's Best Places to Work plaque that will be hung in the lobby of Building 4800. NASA was named the best place to work in the federal government for the fifth straight year and Armstrong rated 28th.

AFRC2017-0060-05 NASA/Lauren Hughes

AFRC2017-0067-2 NASA/Lauren Hughes

NASA Armstrong's Arcata Service Desk was awarded its fifth Help Desk Institute Customer Satisfaction Elite 50 honor in a row. The award recognizes outstanding technical service and support centers around the world. At left are Heather McCoy, from left, Liz Higgins and Cindy Blanco.

DC-8 survey mission is ongoing

By Ellen Gray
NASA's Earth Science News Team

Earth is a planet that "breathes" with the seasons. In winter months atmospheric gases and air pollution accumulate, waiting dormant until spring and summer bring sunshine and plant-life, sparking transformations that change the make-up of gases in the atmosphere. A NASA airborne mission took a world-wide survey of these seasonal transformations by flying from the heart of winter in the Northern Hemisphere, down into the sunny summer in the Southern Hemisphere and back again.

This was the second atmospheric survey made by the Atmospheric Tomography, or ATom mission, which first flew in July and August 2016. The science team measured more than 200 gases as well as airborne particles aboard NASA's DC-8 flying laboratory, which is based at NASA Armstrong. In particular, scientists are interested in greenhouse gas pollutants such as methane and tropospheric ozone and poorly understood particulates like black carbon. How these pollutants interact and move around the planet will help scientists better understand air pollution and climate change now and in the future.

"We went to the northern polar regions at the very best time," said Steven Wofsy, an atmospheric scientist at Harvard University in Cambridge, Massachusetts, and

DC-8 page 9

News at NASA

Scientists study cosmic mystery

A mysterious flash of X-rays has been discovered by NASA's Chandra X-ray Observatory in the deepest X-ray image ever obtained. This source likely comes from some sort of destructive event, but may be of a variety that scientists have never seen.

The X-ray source, located in a region of the sky known as the Chandra Deep Field-South, has remarkable properties. Prior to October 2014, this source was not detected in X-rays, but then it erupted and became at least a factor of 1,000 brighter in a few hours. After about a day, the source faded completely.

Thousands of hours of legacy data from the Hubble and Spitzer Space Telescopes helped determine that the event likely came from a faint, small galaxy about 10.7 billion light years from Earth. For a few minutes, the X-ray source produced a thousand times more energy than all the stars in this galaxy.

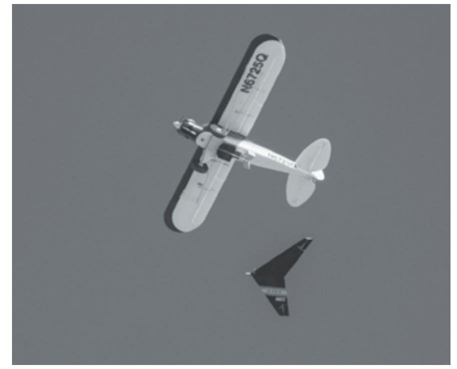
"Ever since discovering this source, we've been struggling to understand its origin," said Franz Bauer of the Pontifical Catholic University of Chile in Santiago, Chile. "It's like we have a jigsaw puzzle but we don't have all of the pieces."

Two of the three main possibilities to explain the X-ray source invoke gamma-ray burst (GRB) events. GRBs are jetted explosions triggered either by the collapse of a massive star or by the merger of a neutron star with another neutron star or a black hole. If the jet is pointing towards the Earth, a burst of gamma rays is detected.

A third possibility is that a medium-sized black hole shredded a white dwarf star.

Progress

Subscale aerodynamic model validates dual purpose airframe


AFRC2017-0048-22 NASA/Ken Ulbrich

By Jay Levine
X-Press editor

Flight tests have resumed on subscale aircraft that could one day observe the Martian atmosphere and a variant that will improve collection of Earth's weather data.

Work on the shape of the aircraft and the systems it will need to fly autonomously and collect data are ongoing for the Preliminary Research Aerodynamic Design to Land on Mars, or Prandtl-M aircraft. Student interns with support from staff members at NASA Armstrong are advancing the project.

The March flights included two slightly different Prandtl-M aerodynamic models that were air launched from a remotely piloted Carbon Cub. The research validated the airframe that will be the basis for a potential Mars aircraft and the Weather Hazard Alert and Awareness Technology Radiation Radiosonde (WHAATRR) Glider on Earth.

In addition to confirming the aircraft's shape, the first flight data was collected on the Prandtl-M flight. Hussein Nasr, an intern at Armstrong pursuing a master's degree in aerospace engineering from California State Polytechnic University in Pomona, was especially excited by the data collection he has been waiting for to refine aerodynamic models. That's not to say he hasn't learned a lot during his wait.

"I learned about simulation testing and how to filter out the noise to get good data," Nasr said. "There is a difference between the theoretical and the real world

Prandtl-M, page 9


AFRC2017-0048-30 NASA/Lauren Hughes

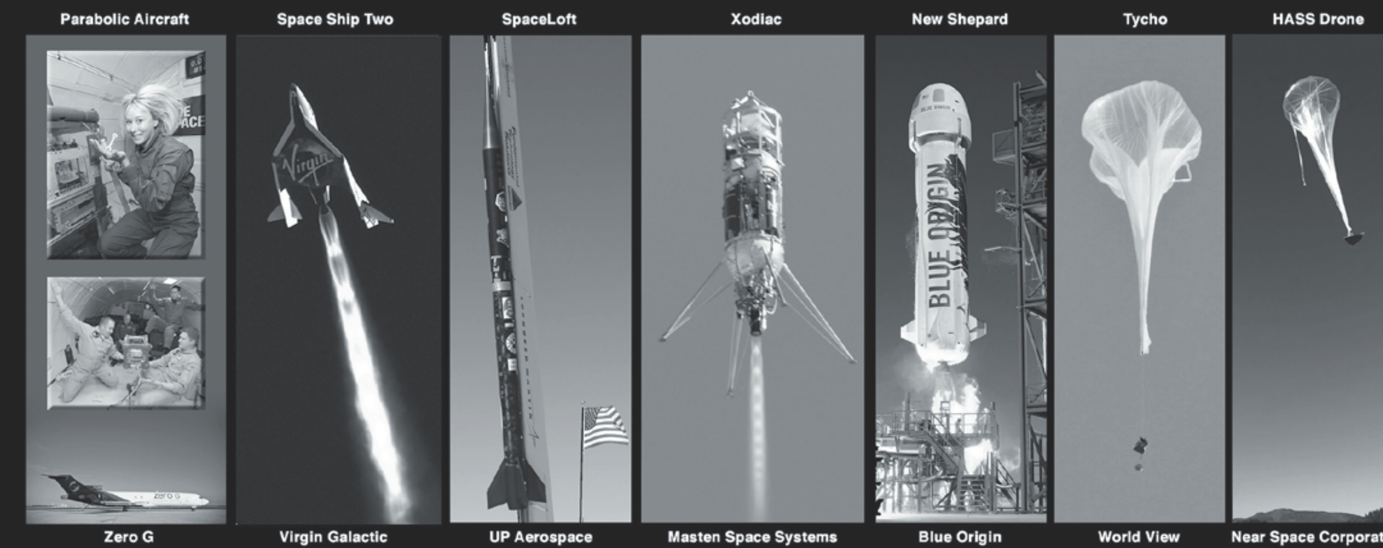
AFRC2017-0048-11 NASA/Lauren Hughes

***Top**, the Carbon Cub air launches the Prandtl-M.*

***Above**, the Prandtl-M flights resumed. The airframe also is the basis for another aircraft that will collect weather data.*

***At left**, Dave Berger, right, and John Bodylski prepare the Prandtl-M for a test flight.*

X-Press March 2017



These are the companies and the vehicles that the Flight Opportunities Program has access to for testing new technologies. NASA Illustration

FOP chooses 5 new technologies

By Kimberly Williams
Ames Public Affairs

NASA has selected five space technologies to test on low-gravity-simulating aircraft, high-altitude balloons or suborbital rockets. The opportunity to fly on these vehicles helps advance technologies closer to practical use by taking them from a laboratory environment to the real world.

The selections were made for NASA's Flight Opportunities program that organizes chances to fly and selects experiments for NASA support twice each year. The program selects promising space technologies to test through relatively low-cost ways that simulate spaceflight or just reach the edge of space on commercial suborbital launch vehicles, reduced gravity aircraft and high-altitude balloon flights.

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

"These selections allow companies and academia to demonstrate technologies of interest to NASA in a much more realistic environment than what they could get in ground-based simulation facilities," said Stephan Ord, the program technology manager for NASA's Flight Opportunities program. "This program is a valuable platform for NASA to mature cutting-edge technologies that have the potential of supporting future agency mission needs."

Two topics were included in this call for research. Under the first topic, which requested demonstration of space technology payloads, NASA selected four proposals:

- **Protein-Drop Pinning in Microgravity**
Amir Hirsa, principal investigator, Rensselaer Polytechnic Institute, Troy, New York
Demonstration of a system for maintaining protein solutions in liquid samples involved in the study of diseases such as Parkinson's and Alzheimer's without using a container, which often influences scientific measurements.
- **Rapid Calibration of Space Solar Cells in Suborbital Environments**
Justin Lee, principal investigator, The Aerospace Corporation, Los Angeles
Demonstration of an automated solar cell calibration platform, using a device attached to a high-altitude balloon to capture the solar spectrum and characterize the performance of the solar cells at high altitude up to 22 miles.
- **Guided Parafoil High Altitude Research II**
Garrett "Storm" Dunker, principal investigator, Airborne Systems, Pennsauken, New Jersey
Demonstration of a new parafoil design that can be used for precision delivery or mid-air retrieval of scientific payloads, tested from a high-altitude balloon. Once the parafoil is deployed at 60,000-foot altitude, it will select its landing point and perform an automatic precision landing.
- **Strata-S1 – Refining a Testbed to Evaluate the Behavior of Regolith Under Microgravity Conditions**
Adrienne Dove, principal investigator, University of Central Florida, Orlando
Demonstration of a regolith compression mechanism with transparent tubes, which contain beads and pebbles that simulate regolith, to evaluate behavior at various gravity levels during suborbital flights.

Under the second topic, demonstration of vehicle capability enhancements and onboard research facilities for payload accommodation, NASA selected one proposal:

- **BioChip SubOrbitalLab: An Automated Microfluidic and Imaging Platform for Live-Cell Investigations in Microgravity**
Daniel O'Connell, principal investigator, HNU Photonics LLC, Kahului, Hawaii
Demonstration of an automated platform to visualize in real time how live cells will react to the different phases of a rocket launch. Cell cultures with fluorescent genes will be pumped through channels and recorded by an optical microscope camera during flight.

Awards will be made for payload integration and flight costs, as well as limited payload development costs. These investments take technologies from the laboratory to a relevant flight environment, facilitate technology maturation, validate feasibility and reduce technical risks and enable infusion of key space technologies into multiple future space missions.

Spectacular!

Armstrong participation strong at Los Angeles County Air Show

AFRC2017-0068-122 NASA/Ken Ulbrich

AFRC2017-0068-061 NASA/Ken Ulbrich

Above, *Armstrong pilot Hernan Posada responds to a request for a selfie.* ***At right***, *an ER-2 flies by the crowd.*

AFRC2017-0068-054 NASA/Ken Ulbrich

Two girls explore a high-altitude flight suit.

Photo courtesy of Jay Levine

Above, *Armstrong pilot Jim Less delivers the F/A-18 for static display at the Los Angeles County Air Show.* ***At right***, *Sam Habbal explains aspects of the King Air aircraft.*

AFRC2017-0068-042 NASA/Ken Ulbrich

AFRC2017-0068-059 NASA/Ken Ulbrich

AFRC2017-0068-113 NASA/Ken Ulbrich

A NASA King Air aircraft was on display at the Los Angeles County Air Show.

AFRC2017-0068-104 NASA/Ken Ulbrich

Flying displays like this wowed the air show crowd.

AFRC2017-0068-026 NASA/Ken Ulbrich

Above, *Matt Kamlet, right, shows some features of the X-57 Maxwell X-plane.* ***At left***, *Kassandra Bell, left, and Michael Woodworth answer questions about the Stratospheric Observatory for Infrared Astronomy.*

Center's research published

NASA Armstrong research led to a number of technical publications.

October

Shun-Fat Lung and William L. Ko co-authored "Applications of Displacement Transfer Functions to Deformed Shape Predictions of the G-III Swept-wing Structure," a meeting paper prepared for presentation at the 30th Congress of the International Council of the Aeronautical Sciences (ICAS), Daejeon, South Korea, Sept. 25-30.

December

Eric J. Miller, Russel Manalo and Alexander Tessler co-authored "Full-Field Reconstruction of Structural Deformations and Loads from Measured Strain Data on a Wing Test Article using the Inverse Finite Element Method," NASA/TM-2016-219407.

Peter M. Suh, Alexander Chin and Dimitri N. Mavis collaborated on "Robust Modal Filtering and Control of the X-56A Model with Simulated Fiber Optic Sensor Failures," NASA/TM-2016-219430.

January

Devin K. Boyle wrote "Acoustic Detection of Faults and Degradation in a High-Bypass Turbofan Engine during Vehicle Integrated Propulsion Research (VIPR) Phase III Testing," AIAA-2017-0933, prepared for presentation at the AIAA Science and Technology Forum and Exposition (SciTech 2017), Grapevine, Texas, Jan. 9-13.

Joel C. Ellsworth authored "Dynamic Leading Edge Stagnation Point Determination Utilizing an Array of Hot-film Sensors with Unknown Calibration," AIAA-2017-0250, prepared for

Research page 11

Armstrong's contractors win NASA SBA honors

AFRC2017-0060-01 NASA/Ken Ulbrich

Logical Innovations Inc. was selected as the 2016 NASA Armstrong Small Business Prime Contractor of the Year. The company demonstrated its commitment by consistently providing excellent written and oral communication to all its customers, according to the nomination letter. The contractor maintains the utmost professionalism and courtesy to relay information and provide the support necessary to accomplish the tasks assigned. From left to right are Kari Alvarado, Rebecca Lopez, David McBride, Denise Navarro and Robert Medina.

AFRC2017-0060-02 NASA/Ken Ulbrich

Jacobs Technology Inc. was named the 2016 Armstrong Large Business Prime Contractor of the Year. The company provided engineering services to eight different codes for Armstrong projects. Its support is pivotal in advancing NASA's research and research from industry, academic institutions, and other NASA centers, according to the nomination letter. Jacobs' engineering support resulted in accomplishing some first-ever NASA achievements in aerospace. From left are Alvarado, McBride, Brian Eslinger, Robert Guzzo and Medina.

AFRC2017-0060-03 NASA/Ken Ulbrich

The Armstrong 2016 Subcontractor of the Year is Solution One Industries Inc. The company is a subcontractor to Jacobs Technology and performed exceptionally in the areas of instruction, training, flight line operations, mission planning, logistics support and program management for Unmanned Aircraft Systems, according to the nomination letter. From left are Robert Swain, Alvarado, McBride, Tyrone McLaurin, Dawn Snyder and Medina.

Prandtl-M... from page 4

and a lot of data hides in the background."

Finding exactly the right students for each of the many tasks on a project like the Prandtl-M takes planning, coordination and intuition said Dave Berger, a key driver and manager of the education side of the effort.

"It is more important to find that student who has a passion for an area, a desire to be here and enthusiasm for that task – as opposed to finding the best credentialed student," Berger said. "We try to find a match with the students' individual skills."

Finding the right personnel is, "especially important for the Prandtl-M project because every student is a lead, so every student has ownership for their portion and I think that really helps us make progress in all the areas and keep moving forward," Berger explained.

The transition from students' term-to-term college schedule is another challenge.

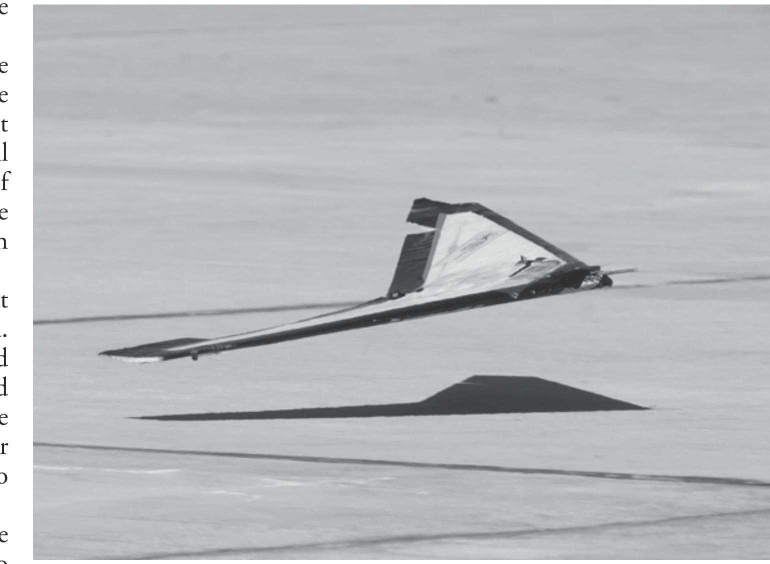
"We get most students from 10 to 16 weeks at a time," Berger explained. "That has helped shape our project culture of documenting procedures so that anyone can come in and figure out and recreate what has been done through the documentation."

Flights with the subscale foam aircraft confirmed the aerodynamics are solid, said Robert "Red" Jensen, Armstrong's Small Unmanned Aircraft Systems chief pilot and master technician for the Dale Reed Subscale Flight Research Model Lab.

"The flights looked at aerodynamic stability," he said. "The design is starting to gel and the target is a stable airframe and fine tuning the autopilot. Then we will target flights from a weather balloon at increasing altitudes to test the systems later this year."

Once the preliminary flights are complete, sensors can be added to collect weather data from weather balloons at Armstrong. The ultimate proof of concept is a flight from a balloon at 100,000 feet altitude or more to demonstrate radiosonde replacement capabilities and returning to the launch site for reuse, said Scott Wiley, Armstrong WHAT-TRR Glider project manager.

Al Bowers, NASA Armstrong chief scientist and Prandtl-M project manager, said systems that will fly on the aircraft during the balloon air launch, such as the guidance



AFRC2017-0048-32 NASA/Lauren Hughes

The Prandtl-M completes a successful research flight.

controller, have already been tested in an altitude chamber at Armstrong up to 126,000 feet altitude.

NASA Innovation Kick Start grant funds the WHAATRR Glider following the project's winning submission during the 2016 NASA Agency Innovation Mission Day in November.

At NASA Armstrong, the Office of Education uses the One Stop Shopping Initiative, or OSSI (https://intern.nasa.gov), as a system for the recruitment, application, selection and career development of high school, undergraduate, and graduate students primarily in science, technology, engineering and mathematics disciplines for projects such as the Prandtl-M. Opportunities for students in other disciplines are available.

DC-8... from page 3

ATom's project scientist.

This winter, they observed the accumulation of pollutants from Europe, the United States, Canada, northern China, and Russia, which get trapped in the cold dome of the wintertime circulation until spring.

"We watched this chemistry using instrumentation that nobody has had before, and we really are beginning to understand what happens as this stuff builds up," Wofsy said.

The winter accumulation of gases sets the stage for the chemical processes that occur in the atmosphere when sunlight returns to the Arctic.

Sunlight is energy, and in the same way that it supports life on Earth through plants' photosynthesis, it also drives the chemical system in the atmosphere. Incoming ultraviolet radiation provides high energy photons that can tear apart gas molecules, transforming them into new highly reactive fragments.

One of ATom's science goals is to understand these photochemical processes which help remove pollutants and greenhouse gases from the atmosphere.

These photochemical processes were in full swing as the mission flew from Alaska down the Pacific Ocean to New Zealand and the Southern Hemisphere in summer.

Because the Southern Hemisphere holds fewer land masses and less of the world's population, the southern atmosphere is generally cleaner than that of the Northern Hemisphere. According to Prather, this means it was easier to observe gases and particles, particularly from marine plants, that react with gases already in the atmosphere. Ocean-related reactions are currently poorly understood and are one of the main reasons ATom is making its survey.

For the around-the-world-journey, NASA's DC-8 aircraft carried more than 20 scientific instruments that measured major and minor gases as well as particles. The plane is about the size of a medium-sized commercial airliner and bristles with intake valves to sample the air. It took a nearly continuous series of gentle descents and ascents in order to capture the most chemically active part of the atmosphere, from the relatively warm humid air above the ocean surface as well as the colder, dry air at its peak altitude of 35,000 feet and everything in between.

After an initial flight from Armstrong to the equator and back, the DC-8 made nine stops over the course of 28 days, departing from California for the North Pole, then on to the tropics, the Southern Ocean around Antarctica, and across to the southern tip of South America before flying north over the Atlantic Ocean toward Greenland, then across the Arctic Ocean back to Alaska. The final leg returned the science team to California.

ATom's winter mission was the second of four deployments scheduled through 2018. It is funded by NASA's Earth Venture program and managed by the Earth Science Project Office at Ames. A team of over 100 people – scientists, engineers, flight crew and staff – across government agencies and universities supported the mission in the air and from the ground.

For more information about the ATom mission, visit: https://www.nasa.gov/content/2016-earth-expeditions-atom

ER-2

Aircraft assisting NASA to get a two-for-one science mission

NASA pulled off a scientific double play in Hawaii this winter, using the same instruments and aircraft to study volcanoes and coral reefs. Besides helping scientists understand these two unique environments better, the data will be used to evaluate the possibility of preparing a potential future NASA satellite that would monitor ecosystem changes and natural hazards.

The advantages of studying active volcanoes from the air rather than the ground are obvious. Coral reefs may not offer the same risks in a close encounter that volcanoes do, but there's another good reason to study them by remote sensing: reefs are dotted across thousands of square miles of the globe. It's simply not feasible to survey such a large area from a boat. NASA has been monitoring coral reefs by satellite and aircraft for several decades. Recent airborne efforts have used sensors that provide better spatial and spectral resolution than currently available from NASA satellite systems.

"Reefs are threatened by bleaching due to rising sea surface temperatures as well as, to some degree, by increasing acidification of ocean waters," said Woody Turner of NASA Headquarters, the program scientist for the recent Hawaii study. "On top of that, since they're coastal ecosystems, they are also subject to sediment and other effluents running offshore. We have an urgent need to get a handle now on how reefs are changing."

Over the past four years, NASA has flown a series of research flights over California, carrying airborne prototypes of instruments in preparation for a possible future satellite mission called the Hyperspectral Infrared Imager (HyspIRI), now in the conceptual design phase. The Golden State has many diverse landscapes to test the instruments' observational capabilities, but not coral reefs or erupting volcanoes. This winter's HyspIRI Hawaii field campaign filled that gap.

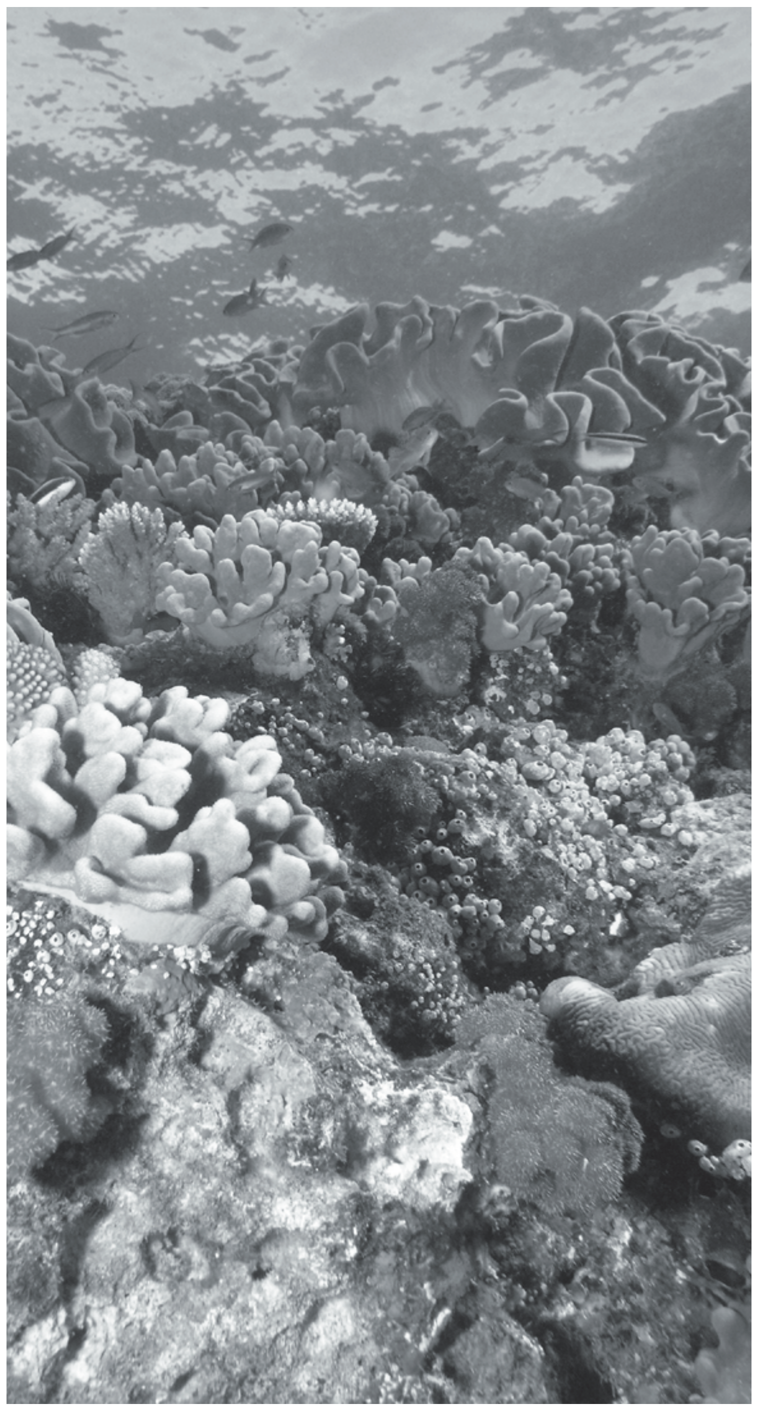
To get the next best thing to a satellite's point of view, HyspIRI Hawaii used a high-altitude ER-2 aircraft from NASA Armstrong. During the study, the aircraft was based at Marine Corps Base Hawaii on the island of Oahu. Flying at approximately 60,000 feet (18,000 meters) and thus above most of Earth's atmosphere, the ER-2 carried the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS), developed by NASA's Jet Propulsion Laboratory, and the MODIS-ASTER Airborne Simulator (MASTER), developed by NASA Ames Research Center.

AVIRIS is an imaging spectrometer that observes the complete reflected spectrum of light in the visible and shortwave infrared wavelengths. MASTER has multiple observational channels in the thermal infrared wavelengths. Together AVIRIS and MASTER provide the same combination of spectral bands planned for the future HyspIRI mission – and powerful data for current coral reef research.

Six coral reef-related projects with diverse objectives are using imagery that AVIRIS and MASTER collected around the Hawaiian archipelago in January through early March.

- Under principal investigator Steven Ackleson (U.S. Naval Research Laboratory, Washington), a team investigated how coral reefs and water quality vary, in both space and time, over the huge distance encompassed by the Hawaiian Islands and the 1,200-mile-long (2,000-kilometer-long) Papahanaumokuakea Marine National Monument north of the main islands. Ackleson's team used the airborne instruments and in-water observations to collect data on reef condition and water quality and compared them with data collected from 2010 to 2014 with a different hyperspectral imager.
- To study reefs' responses to stress, Kyle Cavanaugh (UCLA) led a study of the composition of shallow reefs (coral, algae and sand) and the extent of their bleaching. The team hopes to uncover the practical limits of

Mission, page 11



NOAA

NASA coral reef studies in Hawaii this winter will help scientists understand this unique environment.

Mission... from page 10

the proposed HyspIRI instrument in observing these features. Like Ackleson's and most of the other investigators' projects, this study combined airborne imagery with ocean measurements.

- Heidi Dierssen (University of Connecticut) used in-water spectrometers in conjunction with the airborne AVIRIS imaging spectrometer products to look at pigment differences among corals' photosynthetic algae, known as zooxanthellae. A goal is to determine the degree to which differences in pigment – which relate to different types of algae with different biological characteristics and responses to environmental change – can be detected from an airborne platform and ultimately from space.
- To determine how changes in a reef's environment – cloudiness, water temperature, water murkiness -- might affect coral health, and how these environmental factors themselves might be influenced by changing land use on the islands, Paul Haverkamp (supported by Cramer Fish Sciences, West Sacramento, California) will be comparing this year's AVIRIS data with observations from AVIRIS campaigns flown between 2000 and 2007. The study focuses on reefs in Kaneohe Bay, Oahu, and Kealakekua Bay, Hawaii.
- Eric Hochberg (Bermuda Institute of Ocean Sciences) and his team will compare this year's AVIRIS measurements with AVIRIS data from 2000 to study how human and climate stresses may be affecting reefs around the islands. They will quantify reef composition and primary productivity and correlate them with oceanographic conditions, land use and land cover on the islands, and local human threats to investigate how the reefs' condition and relationship to their environments may have changed in the last 16 years.
- ZhongPing Lee (University of Massachusetts, Boston) took field measurements of reefs concurrently with the HyspIRI flights, using a special system that precisely measures the spectrum of colors in ocean water, which provides important information about what's in the water. Lee and his team measured the shape of the seafloor, the water's optical properties, and other characteristics to compare with the same measurements made by AVIRIS.

Research

... from page 8

presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

Jeffrey Ouellette wrote "Aeroservoelastic Modeling of Body Freedom Flutter for Control System Design," AIAA-2017-0019, prepared for presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

Christopher J. Miller and Dan Goodrick collaborated on "Optimal Control Allocation with Load Sensor Feedback for Active Load Suppression, Experiment Development," AIAA-2017-1719, prepared for presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

Christopher J. Miller, and Dan Goodrick co-authored "Optimal Control Allocation with Load Sensor Feedback for Active Load Suppression, Flight Test Performance," AIAA-2017-1720, prepared for presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

Chan-gi Pak and Shun Fat Lung collaborated on "New Flutter Analysis Technique for Time-Domain Computational Aeroelasticity," AIAA-2017-0856, prepared for presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

John J. Ryan wrote "Methods of Constructing a Blended Performance Function Suitable for Formation Flight," AIAA-2017-1244, prepared for presentation at SciTech 2017, Grapevine, Texas, Jan. 9-13.

AFRC2016-0280-1 NASA/Lauren Hughes

The Advanced Data Acquisition and Telemetry System team includes front row from left Mario Soto, Sam Habbal, Tiffany Titus, Richard Hang, Randy Torres, Thang Quach, Otto Schnarr, Matthew Waldersen, Karen Estes, Andy Olvera, Stanley Wertenberger and Rick Cordes. In the second row from left are John Atherley, Doug Boston, Tom Horn, Brady Rennie, Chris Birkinbine, Jim McNally, Martin Munday and Tony Lorek.

ADATS... from page 2

back to The Hi-Rate Wireless Airborne Network Demonstration (HIWAND) in 2005, which also flew on the King Air. It demonstrated in flight a network-enhanced telemetry system that enabled connectivity between air and ground, including airborne internet access. The capability was focused on allowing scientists and others to downlink scientific data and uplink critical information to airborne sensors more efficiently.

NASA's Flight Demonstrations and Capabilities project, which is part of the Integrated Aviation Systems program, is funding the current effort.

Flow... from page 1

drag that must be overcome is large. Due to the interaction of flow with the aircraft's surface, this friction drag contributes about half of the total drag at supersonic speeds. This particular series of flights will explore ways of reducing friction drag and increasing efficiency through new and innovative methods of achieving swept wing laminar flow.

As an aircraft flies, there is a thin layer of air, called the boundary layer, which exists between the surface of a wing and the fast-moving air around it. This boundary layer generally begins as a smooth, or laminar flow, which creates minimal friction drag. However, as air flow progresses over the aircraft's surfaces, tiny disturbances begin to affect the boundary layer, and it eventually transitions into a more turbulent flow, which produces much more friction drag. On swept wing aircraft, this turbulence presents the aerodynamic challenge of overcoming crossflow on the wing. Crossflow is a name for air flow disturbances that run along the span of the wing, resulting in turbulent flow, increased drag, and ultimately, higher fuel consumption.

Future supersonic aircraft seeking to achieve a low-boom, such as NASA's proposed LBFD, will rely on a swept wing design in order to fly at supersonic speeds without producing a loud sonic boom. The swept wing design generally produces crossflow. NASA believes this obstacle may be overcome through the use of an array of small dots, called distributed roughness elements, or DREs.

"Swept wings do not have much laminar flow naturally at supersonic speeds, so in order to create a smoother flow over the wing, we're putting the DREs along the leading edge of the wing," says CST subproject manager Brett Pauer. "These DREs can create small disturbances that lead to a greater extent of laminar flow."

The DREs work by alleviating the crossflow and delaying the transition to turbulent air flow. The crossflow is essentially crowded out and is not allowed to grow. The boundary layer flow eventually does transition, but it occurs much further along the path of the wing flow, and thus maintains laminar flow for a longer period of time and over more of the wing. The more laminar flow, the lower the overall drag, leading to a more efficient aircraft.

A different configuration of the DREs than that which was expected to work at these high-speed conditions was recently discovered during wind tunnel testing of a wing model at NASA Langley.

"We recently completed testing the 65-degree swept wing model at Langley," NASA Armstrong principal investigator Dan Banks said. "Part of the purpose for the flight tests will be to document the differences in crossflow transition between that which occurs in the wind tunnel and that occurring in flight. Flight testing the exact same test article that was tested in the wind tunnel gives us the best possible comparison."

NASA engineers have integrated the 65-degree wing test article that had been previously tested in the wind tunnel, to the underside of a NASA F-15. The swept wing model will test several configurations of DREs along the test article's leading edge at speeds up to Mach 2. This will allow researchers to examine how different configurations of DREs impact laminar flow.

This will be done by monitoring the flow during flight through the use of an infrared camera mounted under the right inlet of the F-15, which will help interpret which DRE configurations produce the most laminar flow. The camera will monitor flow by picking up signatures of heat produced by air flow, with more heat indicating more friction.

The swept wing laminar flow efforts continue previous NASA research performed using two F-16XL aircraft between 1988 and 1996. Those tests investigated the use of suction to maintain laminar flow using slots, perforations and porous titanium material under the surface of the wing. If successful, the DREs are a much simpler and elegant solution. The wind tunnel tests and NASA Langley were instrumental in discovering the potential for DREs to increase the fuel efficiency of future supersonic aircraft.

"In these wind tunnel tests, we studied a large number of DRE patterns based on subsonic research approaches and none worked at supersonic speeds," NASA Langley principal investigator Lewis Owens said. "The real breakthrough came when we finally abandoned the idea that DRE heights needed to be kept very small and this counter-intuitive approach opened the door to new DRE patterns with the potential to produce the desired supersonic boundary layer control effect."

Swept wing laminar flow technology allows NASA to consider wing designs that have low boom characteristics, yet can be more efficient. In the past, a large extent of laminar flow had only been practically achieved on wing designs with very little sweep. Such designs however are not workable in NASA's efforts to produce a soft thump in place of the sonic boom. The direction of future supersonic aircraft also depends in part on their potential to be more fuel efficient.

If environmental noise standards are identified and met, and are acceptable to the community, the future could be opened to commercial supersonic flight over land, which is currently restricted due to the loud sonic boom.

"Supersonic laminar flow is something of an elusive holy grail for aerodynamicists," states CST project manager Peter Coen. "This test, while still exploring fundamentals, is an important step toward achieving CST's fuel efficiency goals for quiet supersonic overland airliners."

Flights are expected to continue through May.

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