



KENNEDY SPACE CENTER'S

# SPACEPORT

m a g a z i n e

**ORBITAL ATK  
CRS-6 STOCKS  
SPACE STATION**



# KENNEDY SPACE CENTER'S SPACEPORT MAGAZINE CONTENTS

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Front cover: A United Launch Alliance Atlas V rocket lifts off from Space Launch Complex 41 at Cape Canaveral Air Force Station carrying an Orbital ATK Cygnus resupply spacecraft on a commercial resupply services mission to the International Space Station on March 22. Cygnus delivered the second generation

of a portable onboard printer to demonstrate 3-D printing, an instrument for first space-based observations of the chemical composition of meteors entering Earth's atmosphere and an experiment to study how fires burn in microgravity. Photo credit: NASA/Tony Gray & Kevin O'Connell

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## THE SPACEPORT MAGAZINE TEAM

Editorial	Writers Group	Creative Group
Editor.....Frank Ochoa-Gonzales	Anna Heiney	Bob Granath
Assistant Editor.....Linda Herridge	Kay Grinter	Linda Herridge
Copy Editor.....Kay Grinter	Steven Sicheloff	Lynda Brammer
		Matthew Young
		Greg Lee

## NASA'S LAUNCH SCHEDULE

**Targeted Date:** April 8, 4:43 p.m. EDT  
**Mission:** SpaceX CRS-8 Resupply Mission to International Space Station  
**Description:** The Dragon capsule will launch on a Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station (CCAFS) in Florida, carrying science research, crew supplies and hardware to the orbiting laboratory in support of the Expedition 47 and 48 crews.  
<http://go.nasa.gov/1TIH9wd>

**Date:** June 5  
**Mission:** Undocking and Landing of Expedition 47 Crew  
**Description:** Undocking of the Soyuz TMA-19M spacecraft from the Rassvet module and landing in Kazakhstan of the Expedition 47 crew.  
<http://go.nasa.gov/rpDbqR>

**Date:** June 21  
**Mission:** Launch of Expedition 48 Crew  
**Description:** Launch of the Expedition 48 crew on the Soyuz MS-01 spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station.  
<http://go.nasa.gov/1VHuSAv>

**Date:** Sept. 8  
**Mission:** OSIRIS-REx  
**Description:** The mission will study Bennu, a near-Earth asteroid that is about one-third of a mile across. OSIRIS-REx will bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.  
<http://go.nasa.gov/1ItsRkl>

**Date:** Oct. 14  
**Mission:** Geostationary Operational Environmental Satellite-R Series (GOES-R)  
**Description:** The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings.  
<http://go.nasa.gov/1YubP2g>

National Aeronautics and Space Administration



# KENNEDY SPACE CENTER

## JULIE BRYANT

As a member of the Vencore Human Resources team at Kennedy Space Center, it is my privilege to assist employees and managers with any and all HR related matters. I have the opportunity to support employees who work on multiple contracts here at Kennedy, including ESC, ELVIS2 and formerly IMCS.

One of my favorite memories was getting to watch the first shuttle launch as a Kennedy employee, which was Discovery on the STS-114 mission. It was the first shuttle launch after the Columbia disaster in 2003. I never will forget the sense of pride, anxiousness and excitement that we were all feeling as she roared into space. There is nothing like launch day excitement, no matter the vehicle or payload. The rush is always the same.

During the past 10 years, I have seen a lot of change here at Kennedy. But what I haven't seen is a change in the outstanding commitment and passion these employees have for their work. They truly love what they do, which in turn makes me love what I do. I get great satisfaction knowing that I can assist an employee during difficult times or celebrate with them during exciting life events or career achievements.

I grew up in the great state of Kentucky, never thinking I would end up on the Space Coast, but I am so glad I did. This place and its people have forever changed my life for the better, and I am thankful every day to drive through Kennedy's gate and see what's in store for me today.



# CARE SUPPLY

Cygnus cargo ship, Atlas V blaze path to space station

BY STEVEN SICELOFF



A Cygnus cargo spacecraft was prepared inside the Payload Hazardous Servicing Facility at Kennedy Space Center for the Orbital ATK Commercial Resupply Services-6 mission. Photo credit: NASA/Bill White

to examining a new adhesive method inspired by the microscopic hairs that let geckos climb and hang upside down. Cygnus is also carrying a next-generation 3D printer designed to manufacture items in orbit.

“Clearly this team was ready to go do this launch,” said Kenny Todd, the space station’s Operations Integration manager. “The space station is ready and the crew is ready.”

Named for the late astronaut and Shuttle Commander Rick Husband, the Cygnus carries cargo to the orbiting laboratory; no astronauts are onboard the spacecraft. The spacecraft flies

**M**ore than 3½ tons of science experiments, flight equipment and supplies are on their way to the International Space Station following the liftoff at 11:05:52 p.m. EDT on March 22 of a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station in Florida carrying an Orbital ATK Cygnus spacecraft.

The experiments are critical to the station’s mission to carry out research that benefits everyone on Earth in a wide variety of disciplines. Astronauts on the station also perform scientific examinations aimed at deciphering solutions for the challenges crews of deep-space missions will face on a journey to Mars. The international crews of Expeditions 47 and 48 will conduct about 250 scientific studies during their work on the station, dozens of them supported by the equipment carried on the Cygnus.

The investigations will cover areas ranging from fire in space, to observing meteors from orbit as they dive into Earth’s atmosphere,

autonomously and is overseen by ground controllers at Orbital ATK’s control center in Dulles, Virginia, as well as by Mission Control at Johnson Space Center in Houston.

The launch pad at Space Launch Complex 41 shone brilliantly against the pitch black of night when the Atlas V’s first stage engine revved to life and lifted the 19-story-tall rocket and spacecraft straight up. The yellow-orange flames of the exhaust illuminated the clear sky for miles around as the rocket carried Cygnus on an arcing path that lined up closely with the space station’s orbit. This was the second Cygnus to liftoff on an Atlas V.

After about four minutes and 15 seconds of flight, the empty first stage was jettisoned as scheduled so the Centaur upper stage could power the Cygnus the rest of the way into orbit. A 14-minute burn was enough to place Cygnus on its proper course. After maneuvering the spacecraft into the correct position, the Centaur was jettisoned and Cygnus flew on its own, opening its twin, circular solar arrays a few minutes later to recharge its batteries using solar energy.

“We all know it takes a lot of hard work to make it look easy and the team did that,” said Frank Culbertson, president of Orbital ATK’s Space Systems Group.

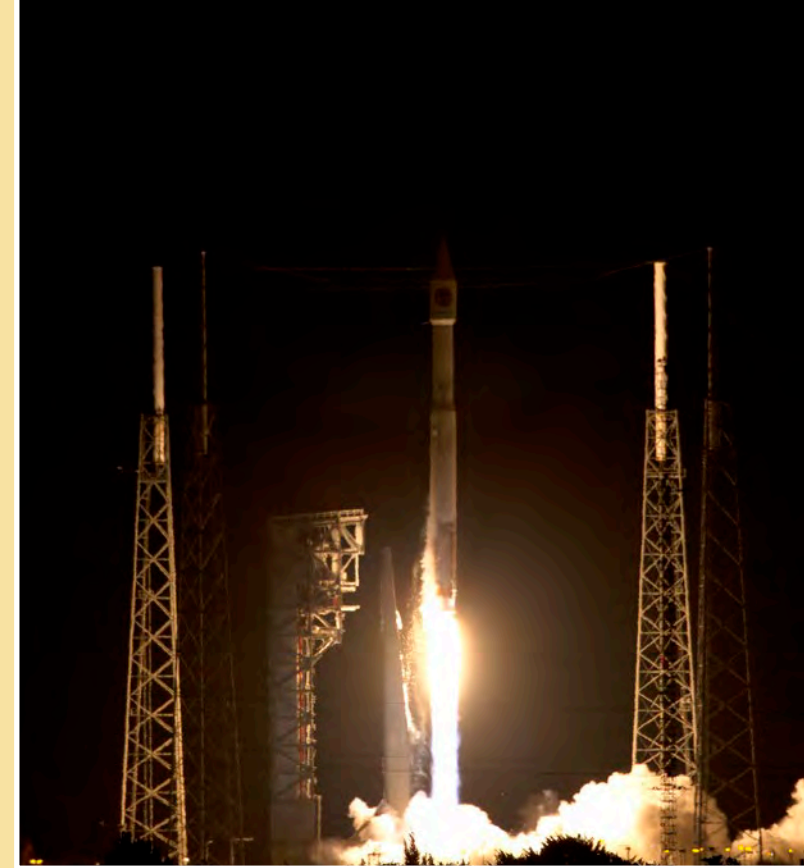
The cylindrical Cygnus, measuring about 21 feet long and 10 feet in diameter, approached the space station March 26. Flying a precise course, the Cygnus maneuvered within reach of the station’s 55-foot-long robotic arm. NASA astronaut Tim Kopra and European Space Agency astronaut Tim Peake used the arm to grapple the Cygnus and pull it toward the Earth-facing port of the Unity module where it will be berthed for about two months.

**“We all know it takes a lot of hard work to make it look easy and the team did that.”**

Frank Culbertson  
President of Orbital ATK’s Space Systems Group

Astronauts unloaded the spacecraft before steadily loading it with about 3,000 pounds of expended equipment and trash. Sometime in May, the astronauts will use the arm again to release Cygnus into its own orbit. Flying by itself again and with no one onboard, the automated Saffire experiment will be activated to study the spread of a large fire in space. Previous research has focused on very small combustion studies, but this one is deemed crucial to seeing how a large fire spreads in microgravity so in an unlikely emergency, future crews can know how to fight such a blaze.

The Cygnus will steer itself into the atmosphere to close out the mission a few days later when it burns up and falls into the Pacific Ocean.



▲ The United Launch Alliance Atlas V rocket carrying an Orbital ATK Cygnus cargo spacecraft lifts off March 22 from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida. Photo credit: NASA/Kim Shiflett

▼ Spectators watch a United Launch Alliance Atlas V rocket lift off March 22 carrying an Orbital ATK Cygnus cargo spacecraft to begin the CRS-6 mission. Photo credit: NASA/Ben Smegelsky



To watch a video of the Orbital ATK Cygnus cargo craft launching atop a United Launch Alliance Atlas 5 rocket March 22, go to <http://go.nasa.gov/1WNXgS6>



# Orion Suited Crew Testing

For more, go to <http://www.nasa.gov/orion>

Engineers at NASA's Johnson Space Center in Houston are evaluating how crews inside a mockup of the Orion spacecraft interact with the rotational hand controller and cursor control device while inside their Modified Advanced Crew Escape spacesuits. The controllers are used to operate Orion's displays and control system, which the crew will use to maneuver and interact with the spacecraft during missions to deep space destinations. The testing aims to provide data that teams need to make sure astronauts who ride to space in Orion can appropriately interact with the control system while in their suits. Credit: NASA

# The Science Behind Scott Kelly's #YearInSpace

Through research on astronaut Scott Kelly in seven major areas, we will improve our understanding of how the human body reacts to long-duration spaceflight. Testing began one year before his launch, intensified during his 340 days in space, and will continue for a year — or longer — after his return to Earth. The results of this research will help prepare us for future voyages beyond low-Earth orbit.



## Visual Impairment

Has Scott's vision been impaired? Fluid shifts in microgravity can put pressure on the optic nerves. These investigations examine ocular health and the body's response to fluid shifts in a microgravity environment.

## Human Factors

Will Scott's fine motor skills, which are important to controlling a spacecraft, diminish? These investigations also examine how astronauts interact with their environment aboard the International Space Station.

## Microbial

Will the collection of microbes in and on Scott's body change in space? Environmental factors like stress and diet can affect the microbiome, which can — in turn — affect overall health. These investigations examine changes in the microbiome of astronauts during spaceflight.

## Functional

Can Scott perform tasks such as opening a spacecraft hatch after landing or walking? These investigations examine the changes in an astronaut's performance of basic tasks and related psychological responses after 12 months in space.

## Behavioral Health

Has living in space affected Scott's psychological health? Stressful environments can impair cognitive performance. These investigations measure reaction time, reasoning and mood.

## Metabolic

With samples of blood, urine and saliva, we're getting a comprehensive look at Scott's overall health, including his immune system and nutritional status.

## Physical Performance

How strong are Scott's bones, muscles and cardiovascular system? These investigations examine exercise capability with a focus on physical performance.

Learn more about every #YearInSpace investigation at: [www.nasa.gov/1ym/research](http://www.nasa.gov/1ym/research)



# SOLID ROOTS

## Commercial Crew uniquely designing with safety from the ground up

BY STEVEN SICELOFF

NASA's Commercial Crew Program is set to return human spaceflight launches to the International Space Station from U.S. soil. We share accountability with our commercial providers, Boeing and SpaceX, to implement a robust process for the development of safe, reliable and cost-effective commercial crew transportation systems. NASA's critical obligation is to ensure crew safety and success for NASA missions, and the providers are each responsible for safe operations of commercial crew transportation systems.

Boeing and SpaceX are designing, developing, testing and evaluating the systems. NASA is accountable for ensuring compliance to the agency's human spaceflight requirements, drawing from and sharing its 50 years of human spaceflight knowledge.

"Collectively, we say our job is to make sure that when the crew enters the spacecraft prelaunch, that they go home to their family," said Billy Stover, commercial crew's Safety and Mission Assurance officer. "When we say it like that, it starts to become very crystal clear, at least to our team. When we talk safety, it's about what can hurt the crew and how can we prevent it. That makes it very tangible, very realistic and something you can actually grasp."

One of the first requirements for the program included provisions to equip spacecraft with launch escape systems to survive launch and ascent emergencies. From there, each design phase has included ever-more-exacting consideration of safety factors in areas ranging from subsystems, to integrated systems, to mission operations.

Astronaut Anne McClain rehearses egress procedures for the SpaceX Crew Dragon spacecraft in a mockup at the company's headquarters in Hawthorne, California. Astronauts work with designers, engineers and specialists in NASA and at aerospace partners to evaluate mechanisms, procedures and other aspects of a spacecraft for safety, operability and numerous other factors. SpaceX is developing the Crew Dragon and Falcon 9 integrated system in partnership with NASA's Commercial Crew Program to fly astronauts to the International Space Station from the United States. Photo credit: SpaceX



Astronaut Suni Williams jumps into the Hydro Impact Basin at NASA's Langley Research Center after completing a practice session with an Air Force pararescue team with a mock-up of a Boeing CST-100 Starliner. Photo credit: NASA/ Langley Research Center

Boeing and SpaceX have built simulators and mock-ups that design teams work in and refine with an eye toward safety, as well as practicality and manufacturing. Like previous human spaceflight programs, the astronauts will have extensive training prior to flight, so that they are prepared to fly the spacecraft on launch day. The crews will have rehearsed every scenario possible in the commercial crew vehicles before their first mission.

Astronauts have been deeply embedded with all the testing and evaluations throughout, too. They work through regular and contingency scenarios frequently with Boeing and SpaceX designers and engineers.

For the astronauts, the focus on safety permeates everything Boeing, SpaceX and NASA are doing.

"I think I just see how important safety is in all aspects, from the everyday aspects to the less routine parts of the mission," NASA astronaut Victor Glover said. "In Mission Control, we talk about the safety of the crew, the safety of the vehicle and the safety of the mission — in that order. So at every level in this agency, I see safety as an integral part of what we do."

The safety considerations go far beyond equipment and reach into numerous processes to make sure unintended consequences of adjustments are fully known.

For example, NASA, the Air Force, Air Force Reserve, and Air National Guard recently held one of their first

astronaut rescue exercises of the commercial crew era off Florida's coast.

"From a safety perspective, Exercise Tern Migration allowed our Guardian Angel teams an opportunity to refine existing techniques they will use to rescue astronauts during a spacecraft landing contingency," said Lt. Col. Jason Havel of the 45th Operations Group Detachment 3, who plans the Department of Defense rescue support to NASA. "Our rescue forces conducted four air drop scenarios from a C-17 aircraft allowing us to refine the techniques needed to rescue astronauts from spacecraft during off-nominal landing scenarios."

Days later, some of the same rescue forces, including Air Force pararescuers and astronauts, practiced other aspects of rescue during rehearsals at NASA's Neutral Buoyancy Lab in Houston and at Langley Research Center in Virginia.

Each time, different aspects of recovery operations were focused on, depending on the situation envisioned and teams required. For instance, the operation in Florida required several aircraft and numerous communications links between a network of pilots, controllers and stand-in astronauts spread miles apart from each other as they would be in the unlikely event that their spacecraft had to make an emergency escape from a failing rocket and splash down in the ocean. For that exercise, a life raft about the



size of a spacecraft was used by engineers and active duty Air Force personnel acting as astronauts who needed to be pulled from the water and treated.

The work at the other locations had a much tighter scope, such as astronauts practicing exiting the Crew Dragon inside a Crew Dragon mock-up at SpaceX headquarters in California. At Langley, Boeing dropped a Starliner test article into a giant pool to test the company's contingency landing systems, followed by a test with NASA engineers and Air Force parascuers to perfect the work needed to climb aboard the spacecraft and stabilize it so astronauts could be safely rescued.

"The knowledge we gained at Langley was instrumental in allowing further development of rescue support equipment specific to Boeing's Starliner," said Air Force Maj. Chris Slauson, the Chief of Safety for the 45th Operations Group Detachment 3.

For NASA, the work rehearsing rescue operations — even using simple stand-ins instead of actual spacecraft — is time well spent, because it clears up potential confusion. That is vital to the overall focus on safety and the attention to detail that goes with it.

"Exercises like this are extremely important to the development of tactics, techniques and procedures, as



well as practicing and refining communication protocols between the flight crew and ground support teams for both NASA and the Defense Department," said Tim O'Brien of the Ground and Mission Operations Office in the Commercial Crew Program. "While Air Force Reserve parascuers jumped from the C-17 aircraft and practiced their hands-on skills, real-time coordination took place between those rescue forces, a simulated flight crew, the aircraft, and command centers in order to execute a safe rescue scenario. Every time we conduct an exercise like this, we learn and improve our processes."

Boeing and SpaceX are developing the CST-100 Starliner and Crew Dragon spacecraft, respectively, to take up to four astronauts at a time to the station along with time-critical cargo to the orbiting laboratory. Currently, only a crew of three can travel to the station at a time. By adding a fourth crew member, NASA will double the amount of research time astronauts can perform during their missions, ultimately benefitting everyone on Earth and advancing the technology needed to allow astronauts to make the journey to Mars.

*For more about NASA's Journey to Mars, go to <http://www.nasa.gov/journeymars>*



This artist concept shows a Boeing CST-100 Starliner atop a United Launch Alliance Atlas V at Space Launch Complex 41 for a launch. Image credit: Boeing



This artist concept shows a SpaceX Crew Dragon atop the company's Falcon 9 at Launch Complex 39A for a launch. Image credit: SpaceX

# I Will LAUNCH AMERICA

*“The way I look at it is, if I’m not willing to strap myself in and fly on it, then I’m not willing to agree to certify it.”*

**Ian Kappes**  
Launch Vehicle  
Avionics Systems Lead  
NASA’s Commercial Crew Program

## I Will Launch America: Avionics Engineer Ian Kappes

BY STEVEN SICELOFF

**M**ost people who watch a launch focus on the rocket flying through the sky with lots of smoke and fire, but Ian Kappes trains his eyes solely on a trail of numbers transmitted from the launch vehicle and spacecraft as they soar into orbit.

Kappes leads the launch vehicle avionics systems team for NASA’s Commercial Crew Program, so it’s up to him and a team of engineers nationwide to make sure the computers that control the rockets are up to the responsibility of safely carrying astronauts to the International Space Station. A veteran of NASA’s Space Shuttle Program since 2006, Kappes is now working closely with commercial crew providers Boeing and SpaceX on the next generation of human-rated space systems.

Although the new approach by NASA is different from human spacecraft systems development efforts in the past — it relies on the private companies to lead development while NASA provides insight — the thrill of being part of a launch program centered on astronauts remains as intense as ever.

“In my days of shuttle, everyone would stand up to watch the launch through the windows, and I was always the guy plastered to the screen because everything I needed to know about the vehicle was coming across in the numbers on that screen,” Kappes said. “I just looked at the data and knew, ‘OK, we’re here, we’re at this point in the ascent, everything’s good.’”

Before anything is visible to even the most discerning eye surveying the launch vehicle, computers and multitudes of sensors on the rocket can pick up minuscule problems and correct for them.

“The avionics systems and its software are the brain and central nervous system of the entire launch vehicle,” Kappes said. “It is really just like our body’s nervous system — avionics tells you all sorts of information about the vehicle. It’s making the decisions necessary to fly. The avionics is telling you when equipment is within its parameters or when something will fail. It is also cross-communicating between the booster stages and the spacecraft, because the spacecraft and its crew need to know what’s going on with the vehicle.”

Kappes’ team at Kennedy Space Center works in tandem with engineers at the agency’s Johnson Space Center in Houston, Marshall Space Flight Center in Huntsville, Alabama, Langley Research Center in Hampton, Virginia, and Armstrong Flight Research Center in Mojave, California, to certify the systems Boeing

and SpaceX plan to use for commercial crew flights to the station. That means many hours poring over avionics architecture designs, working directly with both partners to identify and control hazards, followed by avionics component and software integrated testing.

The task they are taking on is quite a bit different from their predecessors who designed NASA’s human-rated spacecraft and rockets in-house. For commercial crew, the agency is counting on the American aerospace industry to design and build the space systems. NASA will buy the launch services to carry astronauts to the station.

Before that can happen, though, the companies have to prove their spacecraft, launch vehicles and array of ground support and mission control systems will work safely and reliably. The benefit to NASA is a cost-effective way to transport astronauts to station, enabling the agency to focus more of its resources on the Orion spacecraft and Space Launch System, which will take astronauts farther into deep space than ever before.

“Even though technology has progressed, spaceflight is still complicated,” Kappes said. “The flight software is very complex and there are a lot of different inputs for the avionics components to interpret and react to, especially when you have humans onboard. It’s taken very specialized folks to understand the interactions between these components, identify the potential hazards, and ensure appropriate controls are in place to address each hazard cause.”

Both Boeing, with its CST-100 Starliner spacecraft, and SpaceX, with its Crew Dragon spacecraft, are aiming to launch flight tests in 2017. Starliner will fly atop a United Launch Alliance Atlas V rocket while SpaceX will launch its Crew Dragon aboard the company’s Falcon 9 rocket. Both vehicles have flown repeatedly and have carried uncrewed cargo resupply spacecraft to the station.

So how will Kappes know when the teams and companies have it right?

“The way I look at it is, if I’m not willing to strap myself in and fly on it, then I’m not willing to agree to certify it,” Kappes said. “So I have to look at all the information, and I have to get comfortable that we have a mature design and that we have controlled our hazards. If I’m not comfortable with it, then there needs to be a deeper analysis. I’m not going to ask our flight crew to sit on that launch vehicle and fly, if I am not willing to do the same.”

For more on NASA’s Commercial Crew Program, go to <http://www.nasa.gov/commercialcrew>.

# Oh! K!

A 250-ton crane is used to lower the second half of the K-level work platforms for NASA's Space Launch System rocket into High Bay 3 inside the Vehicle Assembly Building, or VAB, at Kennedy Space Center. The platform will be secured about 86 feet above the VAB floor, on tower E of the high bay. The K work platforms will provide access to the SLS core stage and solid rocket boosters during processing and stacking operations on the mobile launcher. The Ground Systems Development and Operations Program is overseeing upgrades and modifications to High Bay 3 to support processing of the SLS and Orion spacecraft. A total of 10 levels of new platforms, 20 platform halves altogether, will surround the SLS rocket and Orion spacecraft. Photo credit: NASA/Dimitri Gerondidakis





# BOOSTER PREP

## Pathfinder operations will pave way for Space Launch System processing

BY LINDA HERRIDGE

**N**ASA's Space Launch System rocket, or SLS, will be the most powerful in the world, and is the vehicle that will launch humans beyond low-Earth orbit and on to deep-space destinations as the agency continues its journey to Mars. The Ground Systems Development and Operations Program at Kennedy Space Center is preparing its workforce, facilities and ground support equipment to handle the processing requirements of the SLS rocket and Orion spacecraft for its first launch.

A team of NASA engineers and Jacobs Engineering technicians and crane operators on the Test and Operations Support Contract are preparing for Exploration Mission 1 (EM-1) processing activities. During EM-1, SLS will launch the Orion crew capsule that will travel thousands of miles beyond the moon over the course of about a three-week mission. No humans will be aboard, but it will pave the way for future missions with astronauts. Ultimately, it will help NASA prepare for missions to the Red Planet.

Experienced personnel are leading the preparation effort using pathfinders, or test versions, of an aft skirt and two inert segments of a solid rocket booster (SRB) inside the Rotation, Processing and Surge Facility (RPSF). The aft skirt and booster segments are similar to those that will be used on the SLS rocket. At launch, the twin SRBs will provide more than 75 percent of the total SLS thrust and operate for about two

minutes before separating from the core stage. The aft skirt is at the base of the booster and contains the system that will steer the booster nozzles.

"The RPSF was used for space shuttle booster segments," said acting NASA Integrated Operations Flow Manager David Diaz. "Upgrades and modifications to the heritage test stands and work platforms recently were completed to accommodate the new aft booster assembly, and particularly the longer nozzle."

The SLS will use two, five-segment solid rocket boosters. Each is 177 feet long and 12 feet in diameter, with upgraded avionics and control systems. They each will provide 3.6 million pounds of thrust at launch.

The aft skirt pathfinder was transported from the Booster Fabrication Facility, or BFF, to the RPSF on Jan. 20. The BFF is operated by Orbital ATK for NASA's Marshall Space Flight Center in Huntsville, Alabama. The two booster pathfinder segments arrived by train at Kennedy's Jay Jay railroad yard Feb. 2 from Orbital ATK in Promontory, Utah. The segments were transferred by rail to the RPSF on Feb. 23.

Technicians removed the covers from the boosters and performed a simulated grain inspection of the interiors. Crane operators used the facility's two cranes in tandem to lift the booster segments off

the railcars, raise them to the vertical position and lower them onto test stands. Engineers then hoisted the pathfinder aft segment to the build-up stand and mated it with the aft skirt. Next, the team used a modified dolly and elevator platform to lift and mate the aft exit cone to the aft skirt.

Engineers will next lift the entire aft booster assembly to check for interferences as it is moved to a pallet and then back onto the work platform. The aft assembly will be used to check for interferences with modified ground support equipment. Installation of the core stage adapter ring and struts will be performed before the aft assembly is transported to the Vehicle Assembly Building for additional verification and validation.

"After we've completed pathfinder operations in the RPSF, we will continue with additional testing operations in the Vehicle Assembly Building," said Kerry Christ, project flow manager with Jacobs. "The crane operators in the RPSF will operate the cranes in both facilities."

These pathfinder operations are performed to help verify that the upgrades and modifications completed in the RPSF will support processing requirements for the aft skirt, SRB segments and the integrated aft booster assembly, to ensure a smooth liftoff at launch.



The first of two pathfinders, or test versions, of solid rocket booster segments for NASA's Space Launch System rocket was raised into the vertical position Feb. 25 and then lowered onto a test stand. Photo credit: NASA/Ben Smegelsky



Two cranes are used in tandem to lift the first of two pathfinders, or test versions, of solid rocket booster segments for NASA's Space Launch System rocket away from a railcar inside the Rotation, Processing and Surge Facility high bay at Kennedy Space Center on Feb. 25. The booster segment will be raised into the vertical position. The Ground Systems Development and Operations Program and Jacobs Engineering, on the Test and Operations Support Contract, are conducting a series of lifts, moves and stacking operations using the booster segments, which are inert, to prepare for Exploration Mission 1, deep-space missions and the journey to Mars. The pathfinder boosters arrived at Kennedy from Orbital ATK in Utah aboard an Iowa Northern train contracted by Goodloe Transportation of Chicago. Photo credit: NASA/Ben Smegelsky

# Test Trek

NASA's upgraded crawler-transporter 2 exited the Vehicle Assembly Building at Kennedy Space Center for its trek along the crawlerway to Launch Pad 39B to test recently completed upgrades and modifications for NASA's journey to Mars. The Ground Systems Development and Operations Program at Kennedy oversaw upgrades to the crawler in the VAB. The crawler will carry the mobile launcher with Orion atop the Space Launch System rocket to Pad 39B for Exploration Mission 1. Photo credit: NASA/Kim Shiflett



*For more on NASA's crawler-transporter,  
go to <http://go.nasa.gov/1LKc1os>*

National Aeronautics and Space Administration



# FACES OF GSDDO

## GROUND SYSTEMS DEVELOPMENT & OPERATIONS



**Lauren Price**  
Mechanical Engineer in the Engineering Directorate  
Supporting the Ground Systems Development & Operations Program

KENNEDY SPACE CENTER  
Exploration Begins Here

# JUST IN CASE

## Water system tested on Crew Access Arm, White Room

BY STEVEN SICELOFF

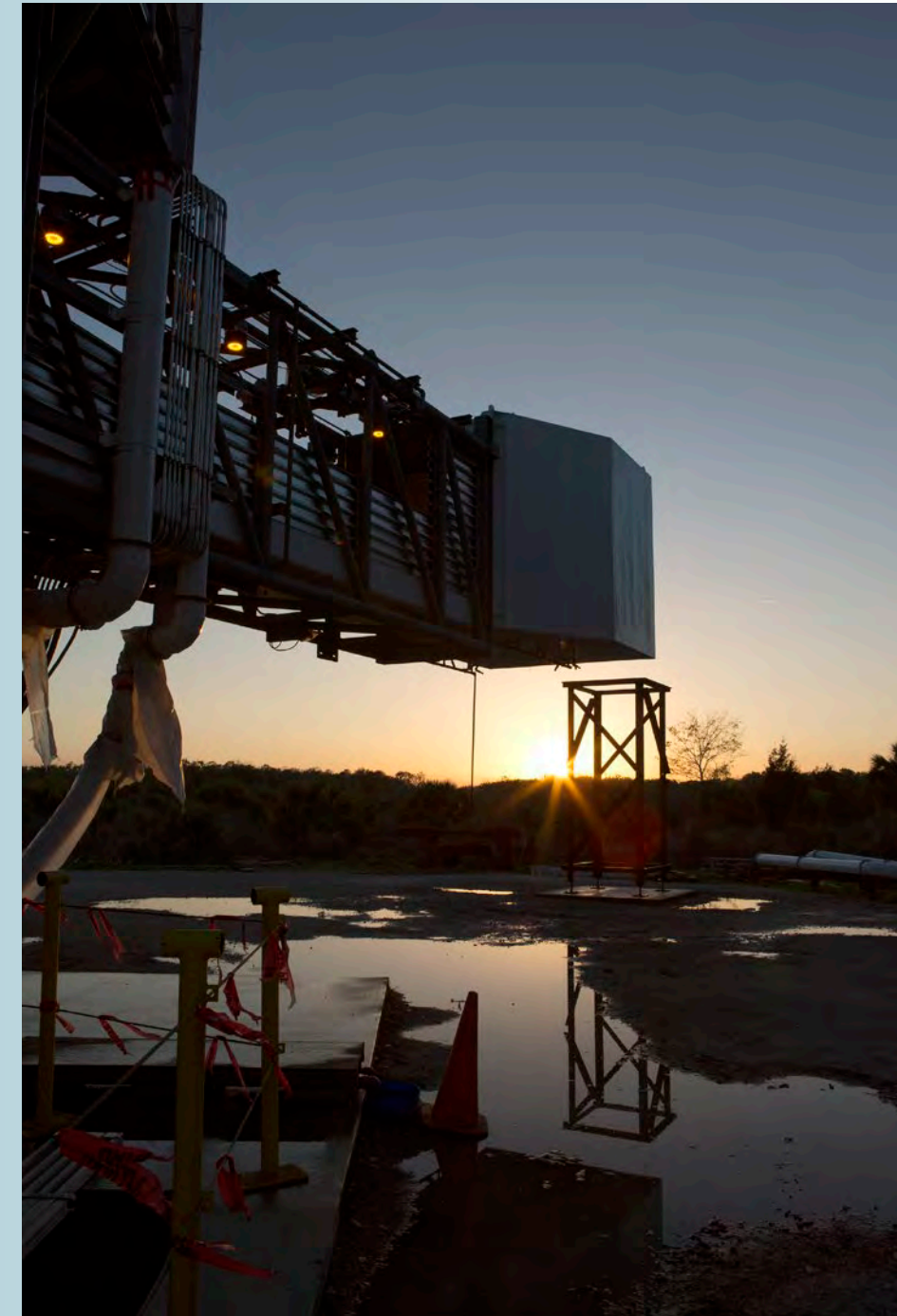
Engineers and technicians gathered at dusk March 23 at a construction site near Kennedy Space Center to test systems that will support Boeing's CST-100 Starliner spacecraft. The Crew Access Arm and White Room saw some of the most dynamic testing thus far, when hundreds of gallons of water were sprayed along the arm and beneath it for an evaluation of its water deluge system. The system is a key safety feature for future launches on the Starliner, one of two commercial spacecraft in development to carry astronauts to the station.

In the unlikely event of an emergency, astronauts ready to launch on future missions aboard the Starliner would need a clear, safe path to exit. The arm and attached white room will provide a bridge between the Crew Access Tower and the spacecraft, as it prepares to launch on a United Launch Alliance Atlas V rocket.

Two rounds of testing in different lighting conditions checked whether the water system could cover the arm adequately and the LED lights were up to the task of helping guide astronauts to safety.

The test mimicked what the system would need to do at the launch pad in case of an emergency. The tower's main structure is already standing at Space Launch Complex 41, the launch site for the Starliner. After more testing on other systems, the arm will be moved to the launch pad later this summer before being lifted into place on the tower.

NASA's Commercial Crew Program will return human spaceflight capabilities to the U.S. on commercial spacecraft. Boeing and SpaceX are developing separate spacecraft and launch systems along with a network of mission and ground support capabilities. Commercial crew flights will add an additional crew member to the station, effectively doubling the amount of time dedicated to research aboard the orbiting laboratory.



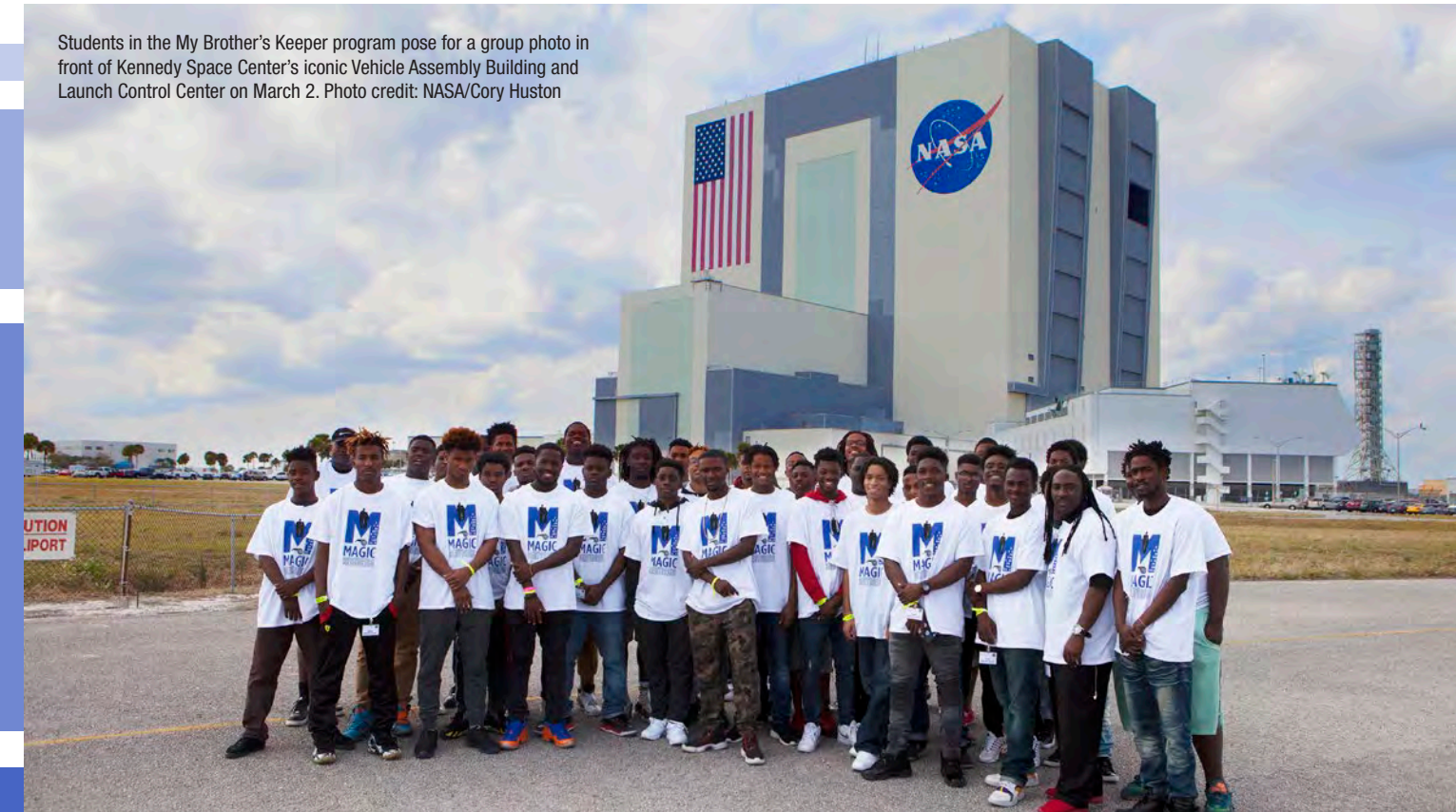
The Crew Access Arm is seen following a water deluge systems test March 23 at a construction yard near Kennedy Space Center. The arm is being tested before being installed on Space Launch Complex 41 Crew Access Tower later this year. It will be used as a bridge by astronauts to board Boeing's CST-100 Starliner spacecraft as it stands on the launch pad atop a United Launch Alliance Atlas V rocket. Photo credit: NASA/Ben Smegelsky.

# MY BROTHER'S KEEPER NATIONAL LAB WEEK @ KSC

The Florida spaceport is one of six NASA centers that participated in My Brother's Keeper National Lab Week. The event is a nationwide effort to bring youth from underrepresented communities into federal labs and centers for hands-on activities, tours and inspirational speakers. Sixty students from the nearby cities of Orlando and Sanford visited Kennedy, where they toured the Vehicle Assembly Building, the Space Station Processing Facility and the center's innovative Swamp Works Labs. The students also had a chance to meet and ask questions of a panel of subject matter experts from across Kennedy.



Mike Lane demonstrates a 3-D scanner inside the NASA Kennedy Space Center Prototype Lab for students in the My Brother's Keeper program March 2. Photo credit: NASA/Cory Huston



Students in the My Brother's Keeper program pose for a group photo in front of Kennedy Space Center's iconic Vehicle Assembly Building and Launch Control Center on March 2. Photo credit: NASA/Cory Huston



Students in the My Brother's Keeper program get an inside look at Kennedy Space Center's iconic Vehicle Assembly Building from the transfer aisle March 2. Photo credit: NASA/Cory Huston



Students in the My Brother's Keeper program watch as Jose Nunez of Kennedy Space Center's Exploration Research and Technology Programs demonstrates some of the hardware in the Electrostatic and Surface Physics Lab at the Florida spaceport March 2. Photo credit: NASA/Cory Huston



Harold (Russ) McAmis demonstrates machinery inside Kennedy Space Center's Prototype Lab for students in the My Brother's Keeper program March 2. Photo credit: NASA/Cory Huston



Steve Starr, a project manager with Vencore, talks to students in the My Brother's Keeper program inside the transfer aisle of the Vehicle Assembly Building at Kennedy Space Center. Photo credit: NASA/Cory Huston

# On Track

## Jason-3 begins mapping oceans, sees ongoing El Niño

Jason-3, a new U.S.-European oceanography satellite mission with NASA participation, has produced its first complete science map of global sea-surface height, capturing the current signal of the 2015-16 El Niño.

The map was generated from the first 10 days of data collected once Jason-3 reached its operational orbit of 830 miles last month. It shows the state of the ongoing El Niño event that began early last year. After peaking in January, the high sea levels in the eastern Pacific are now beginning to shrink.

Launched Jan. 17 from California's Vandenberg Air Force Base, Jason-3 is operated by the National Oceanic and Atmospheric Administration (NOAA) in partnership with NASA, the French Space Agency Centre National d'Etudes Spatiales (CNES) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Its nominal three-year mission will continue nearly a quarter-century record of monitoring changes in global sea level. These measurements of ocean surface topography are used by scientists to help calculate the speed and direction of ocean surface currents and to gauge the distribution of solar energy stored in the ocean.

Information from Jason-3 will be used to monitor climate change and track phenomena like El Niño. It also will enable more accurate weather, ocean and climate forecasts, including helping global weather and environmental agencies more accurately forecast the strength of tropical cyclones.

Jason-3 data also will be used for other scientific, commercial and operational

applications, including monitoring of deep-ocean waves; forecasts of surface waves for offshore operators; forecasts of currents for commercial shipping and ship routing; coastal forecasts to respond to environmental challenges like oil spills and harmful algal blooms; and coastal modeling crucial for marine mammal and coral reef research.

"Jason-3 has big shoes to fill," said Josh Willis, NASA project scientist for Jason-3 at NASA's Jet Propulsion Laboratory in Pasadena, California. "By measuring the changing levels of the ocean, Jason-2 and its predecessors have built one of the clearest records we have of our changing climate."

That record began with the 1992 launch of the NASA/CNES Topex/Poseidon mission (1992-2006) and was continued by Jason-1 (2001-2013) and Jason-2, launched in 2008 and still in operation. Data from Jason-3's predecessor missions show that mean sea level has been rising by about 0.12 inches a year since 1993.

During the past several weeks, mission controllers have activated and checked out Jason-3's systems, instruments and ground segment, all of which are functioning properly. They also maneuvered Jason-3 into its operational orbit, where it now flies in formation with Jason-2 in the same orbit, about 80 seconds apart. The two satellites will make nearly simultaneous measurements during the mission's six-month checkout phase to allow scientists to precisely calibrate Jason-3's instruments.

John Lillibridge, NOAA Jason-3 project scientist in College Park, Maryland, said comparisons of data from the two satellites show very close agreement. "It's really

fantastic. The excellent agreement we already see with Jason-2 shows us that Jason-3 is working extremely well, right out of the box. This kind of success is only possible because of the collaboration that's been developed between our four international agencies over the past quarter century."

Once Jason-3 is fully calibrated and validated, it will begin full science operations, precisely measuring the height of 95 percent of the world's ice-free ocean every 10 days and providing oceanographic products to users around the world. Jason-2 then will be moved into a new orbit, with ground tracks that lie halfway between those of Jason-3. This move will double coverage of the global ocean and improve data resolution for both missions. This interleaved mission will improve our understanding of ocean currents and eddies and provide better information for forecasting them throughout the global oceans.

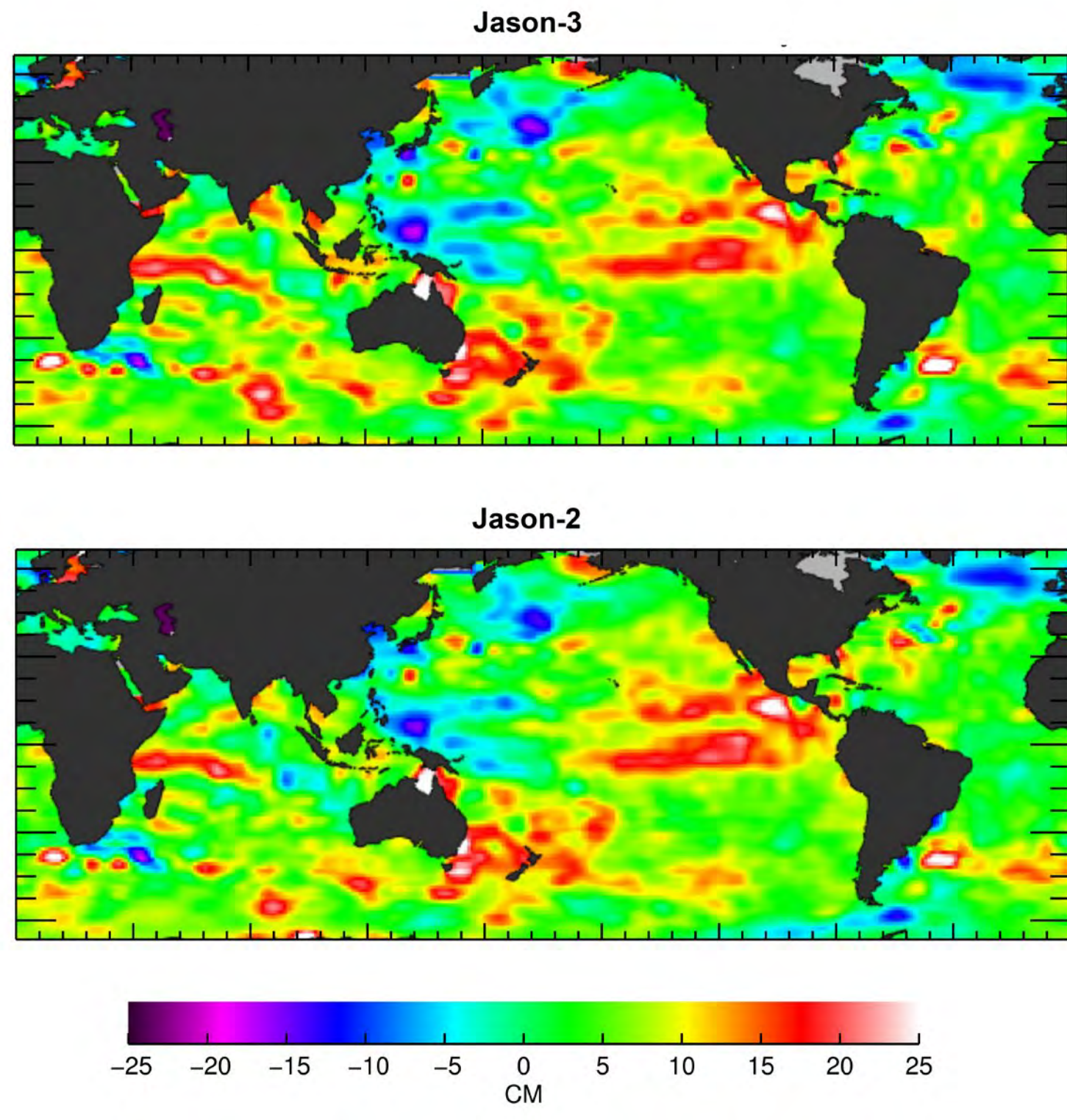
NASA and CNES shared responsibilities for Jason-3's satellite development and launch. CNES provided the Jason-3 spacecraft, while NASA was responsible for management of launch services and countdown operations for the SpaceX Falcon 9 rocket.

NASA uses the vantage point of space to increase our understanding of our home planet, improve lives and safeguard our future. NASA develops new ways to observe and study Earth's interconnected natural systems with long-term data records. The agency freely shares this unique knowledge and works with institutions around the world to gain new insights into how our planet is changing.

The first Jason-3 global map can be viewed at: <http://go.nasa.gov/1pBYtB0>

For more information on Jason-3, visit: <http://sealevel.jpl.nasa.gov/missions/jason3/>

For more information about NASA's Earth science activities, visit <http://www.nasa.gov/earth>



The U.S./European Jason-3 satellite has produced its first map of sea surface height, which corresponds well to data from its predecessor, Jason-2. Higher-than-normal sea levels are red; lower-than-normal sea levels are blue. El Niño is visible as the red blob in the eastern equatorial Pacific.

Extending the timeline of ocean surface topography measurements begun by the Topex/Poseidon and Jason-1 and Jason-2 satellites, Jason-3 will make highly detailed measurements of sea-level on Earth to gain insight into ocean circulation and climate change.

The satellite successfully launched on Jan. 17 and like its predecessors (Jason-1 and Jason-2, and Topex/Poseidon), is a cooperative of agencies and organizations around the world.

# There's No Place Like Home

**NASA gets down to Earth this year with globe-spanning expeditions**



NASA is sending scientists around the world in 2016 — from the edge of the Greenland ice sheet to the coral reefs of the South Pacific — to delve into challenging questions about how our planet is changing and what impacts humans are having on it.

While Earth science field experiments are nothing new for NASA, the next six months will be a particularly active period with eight major new campaigns taking researchers around the world on a wide range of science investigations. The public is invited to follow this journey of exploration online through NASA's social media channels and the new Earth Expeditions webpage, which will feature regular video, photos and blog posts from these missions and other ongoing field activities.

"Combining the long-term global view from space with detailed measurements from field experiments is a powerful way of deciphering what's happening in our world," said Michael Freilich, director of NASA's Earth Science Division in Washington. "Scientists worldwide use NASA Earth science field data together with satellite data and computer models to tackle many of today's environmental challenges and advance our knowledge of how the Earth works as a complex, integrated system."

NASA uses the vantage point of space to increase our understanding of our home planet, improve lives, and safeguard our future with a fleet of orbiting satellites and instruments. To gain a more complete picture of how and why our planet is changing, NASA also sponsors intensive field studies targeting critical science issues that can benefit from a deeper look.



## OMG

The first of the new projects, currently in the field, is an examination of the extent to which the oceans around Greenland are melting the edges of the ice sheet from below. The Oceans Melting Greenland (OMG) team is now conducting its first airborne survey of the ice edge around the entire coast of Greenland. This fall, they will return to measure coastal water temperatures by dropping sensors in the sea from a plane.

**Above:** NASA's Oceans Melting Greenland field campaign is gathering data to clarify how warm ocean water is speeding the loss of Greenland's glaciers. Photo credit: NordForsk



## KORUS-AQ

Air quality is the focus of the Korea U.S. -Air Quality (KORUS-AQ) campaign in South Korea, which begins in May. This joint study between NASA and the Republic of Korea will advance our ability to monitor air pollution from space, with coordinated observations from aircraft, ground sites, ships and satellites.

**Above:** A new field study this May and June seeks to advance NASA's ability to monitor air quality from space. This 2007 NASA satellite image shows a swath of air pollution sweeping east across the Korean peninsula to Japan. Photo credit: NASA



## NAAMES

Also in May, the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) takes to the sea and air for the second year to study how the world's largest plankton bloom gives rise to small organic particles that influence clouds and climate.

Above: The research vessel Atlantis sits at the dock in Woods Hole, Massachusetts. Photo credit: NASA/Rich Moor



## CORAL

In June, the COral Reef Airborne Laboratory (CORAL) project team will begin testing airborne and in-water instruments in Hawaii to assess the condition of threatened coral-based ecosystems. CORAL's next stop, in the fall, will be Australia's Great Barrier Reef.

Above: Coral reef in the Mariana Islands. Photo credit: NOAA/David Burdick



## ACT-America

Focusing on the skies over the eastern half of the United States, the Atmospheric Carbon and Transport — America (ACT-America) research team will track the movement of atmospheric carbon to better understand the sources and sinks of greenhouse gases. Flights will originate from Louisiana, Nebraska and Virginia.

Above: A C-130H Hercules will assist in the airborne campaigns to study the transport of atmospheric carbon. Photo credit: NASA



## ABOVE

Throughout much of this year, teams of scientists working on the Arctic Boreal Vulnerability Experiment (ABOVE) will be in the tundra and forests of Alaska and northwestern Canada investigating the role of climate in wildfires, thawing permafrost, wildlife migration habits and insect outbreaks.

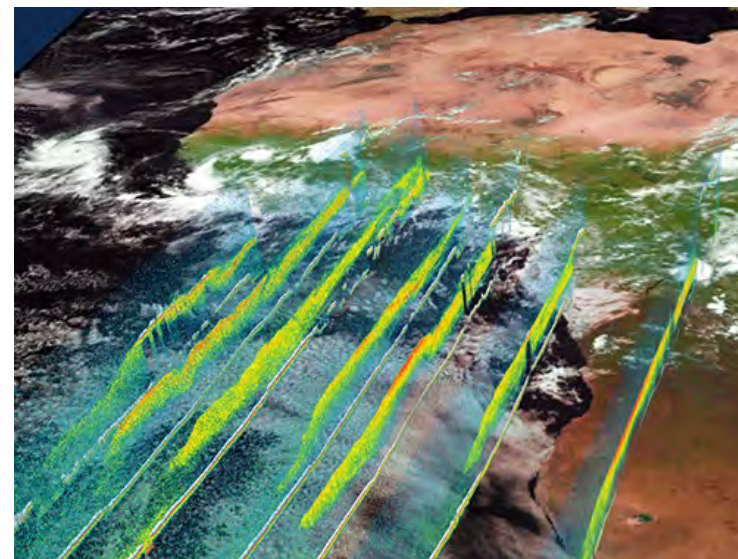
Above: To reach a carbon-measuring instrument station near Denali National Park, ABOVE researchers took a team of sled-dogs. Photo credit: NASA/Peter Griffith



## ATom

Three airborne research campaigns will take to the skies this summer, focusing on critical climate-related components of the atmosphere. Flying tracks over the Pacific and Atlantic oceans thousands of miles long, the team of the Atmospheric Tomography (ATom) mission will gather measurements on more than 200 different chemical species from the ocean surface up to approximately seven miles in the atmosphere to understand how the movement and transformation of short-lived greenhouse gases, such as ozone and methane, contribute to climate change.

Above: A NASA DC-8 taxis on the Runway at Thule Air Base in Greenland. Photo credit: NASA/Kent Schiffer



## ORACLES

The Observations of Clouds above Aerosols and their Interactions (ORACLES) study will use airborne instruments to probe the impact on climate and rainfall of the interaction between clouds over the southeastern Atlantic Ocean and smoke from massive vegetation burning in southern Africa. A better understanding of how the smoke particles alter stratocumulus clouds that play a key role in regional and global surface temperatures and precipitation will help improve current climate models.

Above: Composite CALIPSO lidar backscatter curtains show pervasive transport of BB aerosol transport during the first week of September 2008 as well as the underlying cloud tops. Image credit: NASA



KORUS-AQ and ABoVE originated from NASA's ongoing research program in the Earth Science Division. The other six new experiments are the latest in a series of multi-year NASA Earth Venture Suborbital investigations selected in 2014. Earth Venture projects provide the U.S. scientific community with regular opportunities to accommodate new Earth science research priorities. Earth Venture is part of NASA's Earth System Science Pathfinder program managed at the agency's Langley Research Center in Hampton, Virginia, for NASA's Science Mission Directorate in Washington.

NASA's Stratospheric Observatory for Infrared Astronomy 747SP takes off just before sunset from Air Force Plant 42 in Palmdale, California, on Sept. 15, 2015. Photo credit: NASA/Greg Perryman

# Big Boom

SOFIA observatory indicates star eruptions create and scatter elements with Earth-like composition

by processes inside stars, or during star death throes such as nova and supernova explosions.

The observations of the Nova Delphini debris cloud indicate that novae in general may be a major source of medium-weight elements in the universe. Their paper was published in the *Astrophysical Journal*.

SOFIA's Program Scientist Pam Marcum noted that "these spectra of Nova Delphinium could only be obtained by SOFIA, not by any observatory on the ground or currently in space, because of SOFIA's unique access to the specific range of infrared wavelengths needed for these measurements." She continued, "This research is part of the broad, ongoing effort by astronomers to understand the life cycles of stars and how the formation of planets like Earth fit into those cycles."

The observations for these findings were gathered with the FORCAST instrument on SOFIA, the Faint Object infraRed CAmera for the SOFIA Telescope, which can gather images and spectra of planets, stars, interstellar clouds and galaxies at mid-infrared wavelengths. SOFIA is a Boeing 747SP jetliner modified to carry a 100-inch diameter telescope. NASA's Ames Research Center in Moffett Field, California, manages the SOFIA program. The SOFIA Science Center is based at Ames and managed by NASA in cooperation with the Universities Space Research Association of Columbia, Maryland, and the German SOFIA Institute at the University of Stuttgart. The aircraft is based at NASA's Armstrong Flight Research Center facility in Palmdale, California.

BY DR. DANA BACKMAN  
NASA AMES RESEARCH CENTER

Observations made with NASA's flying observatory, the Stratospheric Observatory for Infrared Astronomy (SOFIA), indicate that nova eruptions create elements that can form rocky planets, much like Earth.

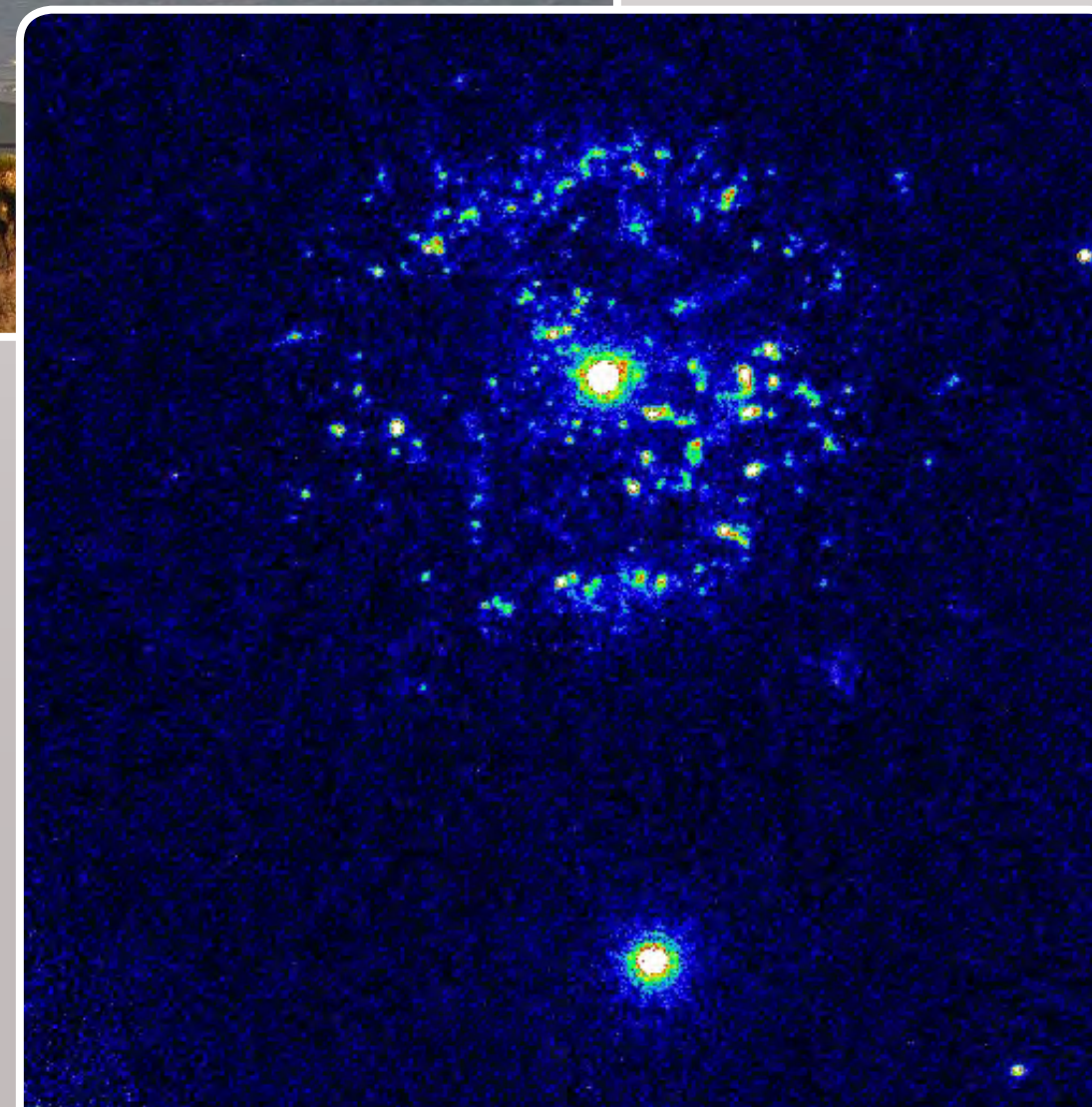
Astronomers occasionally see a nova, which may appear as a "new" star that grows brighter and then fades away after a few weeks. In fact, "nova" plural novae, is the Latin word for "new." We now know that novae are not actually new stars, but rather are associated with stellar old age: explosions occurring on the surfaces of burned-out stars. They are less violent and more common than the star-shattering explosions called supernovae that completely destroy an aging star.

Principal investigator Bob Gehrz of the University of Minnesota

Twin Cities, and collaborators have been using SOFIA to study novae as part of an ongoing research program to understand the role these objects play in creating and injecting elements into the material between the stars called the interstellar medium.

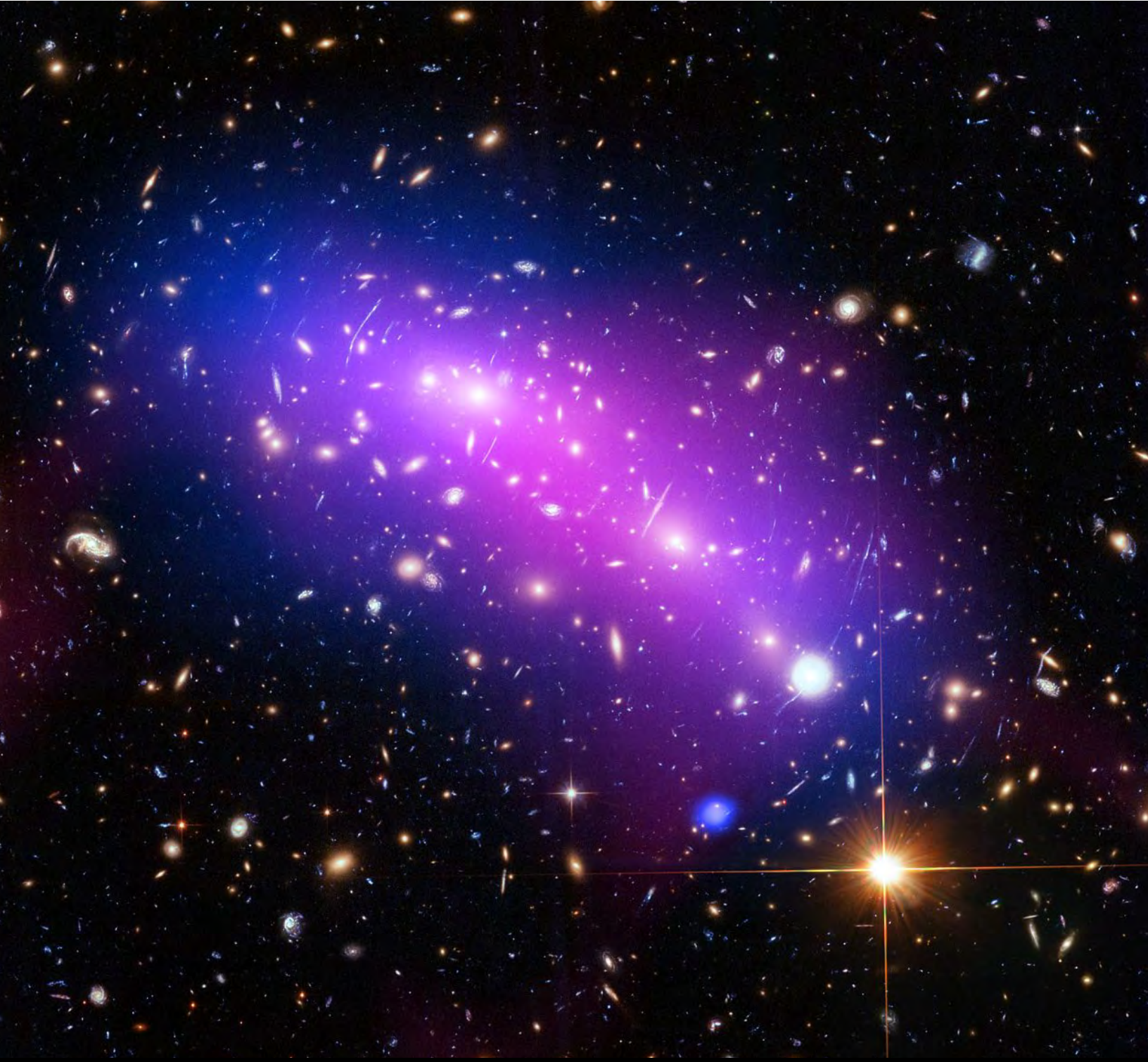
Gehrz and his team found high levels of elements such as carbon, nitrogen, oxygen, neon, magnesium, aluminum and silicon in the Nova Delphini, which erupted in 2013 in the constellation Delphinium (the Dolphin). Some of these elements can be found in living things, whereas others are important constituents of rocky planets such as Earth.

There is evidence that when the universe began in the Big Bang, only trace amounts of elements other than hydrogen and helium were created. Atoms of heavier elements were made later



An image from the Hubble Space Telescope showing debris expanding into space from a typical nova outburst that occurred decades before this picture. The featured research using SOFIA was focused on Nova Delphini 2013, which is too recent to allow a resolved picture of its debris cloud. Photo credit: NASA/ESA/STScI/AURA/NSF/Mike Shara, Bob Williams, David Zurek, Dina Prialnik





At first glance, this cosmic kaleidoscope of purple, blue and pink offers a strikingly beautiful — and serene — snapshot of the cosmos. However, this multi-colored haze actually marks the site of two colliding galaxy clusters, forming a single object known as MACS J0416.1-2403 (or MACS J0416 for short). MACS J0416 is about 4.3 billion light-years from Earth, in the constellation of Eridanus. This image of the cluster combines data from three different telescopes: the NASA/ESA Hubble Space Telescope (showing the galaxies and stars), the NASA Chandra X-ray Observatory (diffuse emission in blue), and the NRAO Jansky Very Large Array (diffuse emission in pink). Each telescope shows a different element of the cluster, allowing astronomers to study MACS J0416 in detail. For more information, check out Hubblecast 90: The final frontier at <http://go.nasa.gov/22A0zBx>

Courtesy of: NASA, ESA, CXC, NRAO/AUI/NSF, STScI, and G. Ogren (Stanford University)

National Aeronautics and Space Administration

**John F. Kennedy Space Center**  
Kennedy Space Center, FL 32899

[www.nasa.gov](http://www.nasa.gov)