Stellar Southern Hemisphere missions mark new day for the program

SOFIA

Southern Hemisphere missions mark new day for the program
A job well done

Fly 6,900 miles each way, deploy a cadre of flight- and ground-crewmembers along with an international science team for three weeks, and during that time fly three nights per week, 10-hours per flight, while conducting world-class science. It’s a lot to imagine and even greater to have accomplished it all.

To meet our program goals set earlier this year, the Stratospheric Observatory for Infrared Astronomy, or SOFIA, departed the United States on July 12, for the first leg of its deployment to Christchurch, New Zealand. Having stopped for a flight crew change and some Hawaiian hospitality from the good folks at Joint Base Pearl Harbor-Hickam outside of Honolulu, the observatory arrived the following morning at Christchurch where preparations began for the first of nine science missions.

Water vapor in the Earth’s atmosphere is extremely low during the winter months over the southern oceans, which provides an ideal environment for infrared astronomy. The fact that water vapor interferes with infrared observations was key to our decision to base the observatory at Christchurch. Contributing to that decision was the infrastructure provided by the U.S. Antarctic Program, which is operated by the National Science Foundation, or NSF, from the Christchurch International Airport. During our deployment, the NSF opened its facilities to us, and they, along with everyone at the Christchurch International Airport, were most gracious hosts.

While we were on New Zealand’s southern island, our team was supported by the U.S. State Department and U.S. Ambassador to New Zealand and Samoa David Huebner and his staff who are based in the capital, Wellington, on the northern island. I’d also like to extend a special note of appreciation to all of the New Zealanders who were very interested in our mission and made our team feel most welcome.

For our flights from Christchurch we planned a series of observations using the German Receiver for Astronomy at Terahertz Frequencies, or GREAT, instrument that were proposed by a combination of astronomer guest investigators plus members of the GREAT consortium. A team from the Max Planck Institute for Radio Astronomy, Bonn, Germany, developed the GREAT instrument, which is a spectrometer that detects the wave aspect rather than the particle aspect of infrared light. Among its many other capabilities, GREAT helps astronomers measure the chemical composition of star forming regions and supernova remnants. For this deployment we spent the majority of our time observing the Milky Way Galaxy’s central regions and the Milky Way’s companion dwarf galaxies known as the Magellanic Clouds.

Measuring the chemical composition of the interstellar medium in the Magellanic Clouds enables astronomers to infer conditions right after the “Big Bang” because the material of the clouds has not been recycled through many generations of stars forming and dying. Even though this material has been floating in space for millions of years, it is considered relatively “fresh” and in an unprocessed state. SOFIA’s access to this material means our observatory can, in effect, do cosmology research without the need to make measurements of galaxies billions of light years away. This capability is very exciting to our science staff and the worldwide astronomical community.

SOFIA’s entirely successful deployment to New Zealand, completed on Aug. 2, was very important to our program. We demonstrated the capability to operate the world’s largest, airborne astronomical observatory with high efficiency and reliability, achieving 100 percent of the planned science flights. By all accounts the quality of the scientific data was also outstanding. The international deployment team did an excellent job planning and safely executing every logistical and operational detail, and those of us “left behind” worked hard before and during the deployment to support them. Completing our first scientific deployment is a key accomplishment in our transition to becoming a fully operational observatory.

This cadence was especially challenging to achieve while on deployment and demonstrates that SOFIA is on track to achieving the anticipated Full Operational Capability that will allow the flight rate seen in New Zealand to become routine.

Congratulations to the entire team for this outstanding achievement.

Eddie Zavala
NASA SOFIA program manager

Eddie Zavala is the program manager of the Stratospheric Observatory for Infrared Astronomy, or SOFIA, program. In this position, he is responsible for overall development and operation of the SOFIA Science Center at Ames Research Center, Moffett Field, Calif., and the airborne observatory, which features a German-built 2.5-meter infrared telescope mounted in a highly modified Boeing 747SP aircraft located at Dryden.

The program is a cooperative effort between NASA – including Dryden and Ames research centers – and DLR, the German Aerospace Center. The SOFIA is the agency’s next-generation airborne observatory, which will enable astronomers routine access to the infrared and sub-millimeter portions of the electromagnetic spectrum of the universe.
By Jay Levine

SOFIA program officials said the New Zealand deployment exceeded their expectations. “SOFIA’s first Southern Hemisphere deployment was a huge milestone for the program and a triumph for the NASA and DLR teams,” said Andrea Razzaghi, deputy director of the Astrophysics Division at NASA Headquarters. “SOFIA’s newly-demonstrated ability to observe the Southern skies will allow it to study an exciting collection of astronomical targets.”

The deployment also featured another key accomplishment. “It was a fabulous deployment and a tremendous success with its nine observations,” Razzaghi said. “The deployment increases our confidence in the capabilities of this observatory. It is proving to be a reliable observatory that will provide opportunities for scientific investigation for many years to come.”

Erick Young is the SOFIA Science Mission Operations director and was key in deciding what science would be attempted during the New Zealand deployment. Young, who is based at NASA Ames Research Center at Moffett Field, Calif., said the conditions for science were excellent.

“One of the main reasons for SOFIA is to get above most of the water vapor in the Earth’s atmosphere. During the deployment, we saw some of the lowest water vapor levels ever seen with SOFIA. That means the clarity of the atmosphere at infrared wavelengths was outstanding,” Young said.

The flights also demonstrated SOFIA’s operational capability.

“The team conducted three consecutive flights a week for three weeks in a row. That flight cadence is close to what we will need to operate at the maximum anticipated flight rate and shows that the operations team is ready. The quality of the science results from the deployment will also send strong signals to the scientific community,” Alois Himmes, DLR SOFIA project manager, said.

“Communication is very good despite the distance we have,” Himmes said. “We rely on telecons and e-mail when we are not here and the cooperation onsite with the contractors, Dryden and Ames is very good. All of us function like an integrated team.”

The first and early science flights with SOFIA have already led to a number of published papers. Himmes said he expects that the observatory updates and upgrades will continue to enhance science opportunities, as proven by the New Zealand deployment.

“I am very satisfied with SOFIA, especially with a difficult deployment in New Zealand that went very well. They planned nine flights and all nine flights took place to the minute they were planned. The conditions in New Zealand were excellent for infrared observations. The scientists said it was close to the conditions in space, perhaps that is an exaggeration, but it was very good,” Himmes said.

John Gagosian, who is the SOFIA program executive based at NASA Headquarters, said the deployment exceeded all of his expectations.

“I know we have a great team here and in the past it has really come through when the pressure was on,” Gagosian said. “I was expecting we would get good results, but the fact that 100 percent of the objectives were met was really amazing and we have had the combination of some very compelling targets and the outcome was very pleasing.”

Two elements of the New Zealand deployment stood out.

“We had our first observations of some very compelling targets in the Southern Hemisphere,” he said. “We executed nine science flights over the course of 14 nights, which is by far the most rapid sustained operational period that we have had. The combination of demonstrating SOFIA’s capability to observe these very valuable scientific targets and its ability to observe them at a fast tempo, really make this a huge milestone for the Southern Hemisphere mission.”

The SOFIA is on the tarmac in Christchurch, New Zealand. The team met 100 percent of the science goals for the Southern Hemisphere mission.
the science instrument was how astronomical phenomena were seen. It was a challenge in areas of the sky where there were no stars bright enough to use for accurate pointing and tracking. However, a new focal plane imager camera, with detectors dozens of times more sensitive than the original camera has vastly improved the telescope's performance. Now much dimmer stars can be used to point and track the telescope – in fact about 96 percent of the sky – to observe astronomical items of interest.

“The current angular pointing error is about 0.5 arc seconds. It’s like being able to target an object the size of a nickel 5.5 miles away,” Cobleigh said. “Being off one degree in that example would be the equivalent of the distance of a 40-story building.”

Observatory improvements to the water vapor monitor included autonomous operation and the ability to provide data real time. Another key improvement was to add a data archiver. Once comprised of lots of smaller data recorders all over the aircraft, the centralized archiver has a storage capability of up to nine-terabytes with a backup in case of a failure. In addition, its disk packs can be taken right off the aircraft for analysis and new disk packs can be reloaded for the next mission, he explained.

A massive re-wire of the aircraft was necessary – more than 15,000 wire connections – to integrate the many new systems and be prepared for several important upgrades over the next few years. A key objective was to allocate the power required for the next generation of science instruments. Cobleigh added. The power available for science instruments has more than tripled with these modifications and the aircraft is now able to integrate cryogenic coolers. Instead of constantly refilling liquid nitrogen, future instruments will recycle liquid nitrogen in a loop, like an air conditioner, he explained.

The cavity environmental control system was also upgraded for better performance. The cavity has to keep the environment at 15 degrees Fahrenheit that is encountered at 45,000 feet altitude back to temperatures on the ground.

Also part of the improvements was the addition of an education console, intended for use by educators like the Airborne Astronomy Ambassadors program (see related article). The Airborne Astronomy Ambassadors program is a yearly professional development opportunity extended to educators through a competitive, peer-reviewed process. Teams of two educators are paired with groups of professional astronomers to experience a SOFIA mission first hand. The console allows educators to see the same displays as the mission director and telescope operator.

The cockpit received a major upgrade from 1970s analog data, dials and gauges that were mostly replaced with what’s called a “glass cockpit.” The glass cockpit features electronic screens capable of displaying whatever information the pilot wants to see.

“It was quite a challenge,” Cobleigh said. Specifically, marrying state-of-the-art cockpit systems to the 1970s systems on the one-time airliner were difficult, he added.

Another improvement is the new weather radar that can help the aircraft stay out of turbulent areas, as well as a new radar and navigation system. A separate satellite system provides additional communications abilities for worldwide operations and air traffic and ground avoidance features. A long-range antenna was mounted on the aircraft’s vertical stabilizer to improve communications with air traffic control during long flight segments over the ocean. The new cockpit is more reliable and maintainable, as replacement parts are easier to acquire for the updated
By Jay Levine
X-Press editor

Science conducted aboard the Stratospheric Observatory for Infrared Astronomy (SOFIA) was intended to provide astronomy observations and data that are simply out of this world.

So far, the NASA 747SP observatory that carries the world’s largest airborne infrared telescope has delivered some of the clearest infrared imagery obtained of astronomical objects of interest, said Eric Becklin, SOFIA chief science advisor. Ultimately, science aboard the SOFIA could provide clues to questions such as can life form in space?

SOFIA has distinct advantages over telescopes on Earth because it flies above the atmosphere that obscures infrared observations. It also does something that isn’t currently possible with space-based assets—it can change instruments for different missions and validate the most cutting-edge technology, while using it for science.

“SOFIA is absolutely living up to its expectations, especially on the deployment to New Zealand,” Becklin said. “We are doing unique science that can’t be done any other way.

Everything worked as expected and many new science results were recorded.”

The SOFIA missions in the Southern Hemisphere, which were based in Christchurch, New Zealand in July and August, allowed observations of astronomical objects of interest that can’t be seen as well—or at all—from the Northern Hemisphere.

“A major part of the Milky Way galaxy we can’t see in the Northern Hemisphere,” Becklin explained. “So you have to go down there to see that part of the Milky Way. Two nearby galaxies, the Large and Small Magellanic Clouds, are actually satellites, or companions, to the Milky Way. They can only be studied by going down to the Southern Hemisphere.”

Many findings from the New Zealand missions are not available yet. It takes from one to three years for most major science discoveries to be confirmed and verified before the results can be published, but Becklin gave an overview of some of what the SOFIA missions observed.

Scientists studied a molecule they didn’t know if they would encounter, but hoped they would.

“We studied the deuterated hydrogen molecule, which contains a heavy hydrogen atom,” Becklin said. “The GREAT instrument analyzed it with a significant increase in sensitivity and spectral and spatial resolution than ever seen before.”

From the very first observations with the telescope on May 26, 2010, all indications were that SOFIA was going to be an excellent airborne observatory when its first images of Jupiter were captured using Cornell University’s Point Object Infrared Camera for the SOFIA, or FORCAST, instrument. That activity is referred to as “first light.” Then FORCAST was used again on the first science mission in December 2010.

For that mission, the telescope peered into the nearby Orion nebula that is undergoing a burst of star formation and regions where stars are forming in the Milky Way galaxy.

The flight marked the first time since the Kuiper Airborne Observatory that a telescope in an aircraft completed a science mission. Becklin worked on the KAO, which was based at NASA’s Ames Research Center in Moffett Field, Calif., for 14 years.

The KAO ended 20 years of service and groundbreaking science in 1995 with the intention that SOFIA would be developed to further redefine what is possible with an airborne telescope. It was a long wait, but well worth it, he added.

The first use of the German Receiver for Astronomy at Terahertz Frequencies, or GREAT, in April 2011 was another milestone. The instrument is a high-resolution, far-infrared spectrometer that divides and sorts light for detailed analysis. Some of the key targets of that observation were the IC542, a spiral galaxy located near the bright cluster on the left side of the image. Most of the features in the SOFIA mid-infrared image are not seen in the HST image due to their low temperature and intervening interstellar dust.

Erich Becklin, SOFIA chief science advisor, points out how the telescope tracked a dust cloud in the center of the Milky Way galaxy.

ED13-0228-14X
NASA/Carla Thomas

This is a SOFIA/FORCAST mid-infrared image of the Milky Way galaxy’s nucleus showing the Circumnuclear Ring of gas and dust clouds orbiting a central supermassive black hole. The bright Y-shaped feature is believed to be material falling from the ring toward the black hole located where the arms of the “V” intersect.

Science, page 10

SOFIA/FORCAST mid-infrared image of a region including the Quintuple Cluster (QC), a group of young stars located about 535 parsecs (1,000 light years) from the galaxy’s nucleus. The clump, red objects represent white and blue in this image are dust cloud “cocoons” heated from within by the highest luminosity stars in the cluster to temperatures that make them prominent at mid-infrared wavelengths. Other features in this image are interstellar clouds of gas and dust. The large rounded oblong feature below the QC is an expanding cloud of debris produced by violent ejections of material from a massive star nearing the end of its life.

SOFIA/FORCAST team/Luns et al. 2013

NASA/SOFIA/Hankins et al. 2013

This Hubble Space Telescope Near Infrared Camera and Multi-Object Spectrometer image shows the Milky Way’s Quintuple Cluster, or QC, region matching the SOFIA/FORCAST field of view infrared images. The central bright cluster on the left side of the image. Most of the features in the SOFIA mid-infrared image are not seen in the HST image due to their low temperature and intervening interstellar dust.

NASA/STScI

This is a SOFIA/FORCAST mid-infrared image of the Milky Way galaxy’s nucleus showing the Circumnuclear Ring of gas and dust clouds orbiting a central supermassive black hole. The bright Y-shaped feature is believed to be material falling from the ring toward the black hole located where the arms of the “V” intersect.
11 million light years from Earth and the Omega Nebula, known as M17, which is 5,000 light-years away. GREAT is the instrument used during the New Zealand deployment.

“The GREAT instrument spreads the infrared radiation further than any other instrument,” Becklin said.

“When you spread it further you get more detail about what molecules, or what atoms, are being detected, but you also get Doppler information that can tell you whether a gas or molecule is coming toward you or moving away from you. In addition, it also allows you to start developing the physics of what is happening where you are looking. In particular, it allows researchers to start looking at the density of the material that they are studying and its temperature. The GREAT instrument does this well,” he said.

Using the GREAT instrument on an earlier mission, two new molecules that were previously identified but had never been seen before in the material in between stars were observed. The first is sulfur and hydrogen together and the other was oxygen and deuterium together.

SOFIA was used to observe the Pluto occultation in June 2011, which entailed the dwarf planet passing in front of a distant star. The occultation enabled scientific analysis of Pluto and its atmosphere when SOFIA was dispatched at the right moment to the exact location where Pluto's shadow fell on Earth. Some of Becklin's favorite moments have included observations of star formation at the core of the Orion nebula. “It was known to be a nursery where stars are born. We were able to make SOFIA observations with the best image quality that's ever been made on that region. We had some surprises. Observations from the ground cannot tell the whole story, but SOFIA observations gave us insight into what actually is going on,” he said.

And studies of the massive black hole in the center of the Milky Way have been enlightening. “We were surprised with the spectacular image of dust that is circling around that black hole. It’s a ring that we knew about, but it's uncertain what the next discovery will be, so you’re not just talking about speculation based on the image or that one spectrum where you know what's physically happening out there,” he explained.

Science on SOFIA has been so good that two U.S. industry publications highlighted the program including the "Astrophysical Journal" and the "Journal of Astronomy & Astrophysics." It’s uncertain what the next discovery will be with SOFIA, but what is certain is the best is yet to come.

At left, this mid-infrared image of the W3A star cluster in the inset was captured by the FORCAST camera on the SOFIA flying observatory in 2011. It is overlaid on a near-infrared image of the W3A star-forming region from the Spitzer space telescope.

By Beth Hagenauer
Dyaken Public Affairs

Twenty-six educators from across the United States are experiencing the ultimate classroom aboard the Stratospheric Observatory for Infrared Astronomy, which flies its missions about 43,000 feet above Earth.

Participants in the Airborne Astronomy Ambassadors program, the educator teams of two have been partnered with professional astronomers using SOFIA for scientific observations in 2013. They were selected in January 2012 for research flights out of the airborne observatory.

SOFIA is a modified Boeing 747SP jetliner equipped with a 100-inch (2.5-meter) diameter telescope. The observatory enables the analysis of infrared light to study the formation of stars and planets; chemistry of interstellar gases; composition of comets, asteroids and planets; and supernovae and black holes at the centers of galaxies.

The unique design of SOFIA gives educators hands-on experience with world-class astronomical research,” said John Gagosian, SOFIA program executive at NASA Headquarters in Washington, D.C. “Working with astronomers, educators participate in a research project from beginning to end and integrate that unique perspective with classroom lessons and public outreach programs.”

As the date grew close for their flight aboard the observatory, two Airborne Astronomy Ambassadors from El Paso, Texas, said they were so excited that they had trouble sleeping. Adriana Alvarez and Mariela Aguirre, teachers at Alicia R. Chacon International School, arrived June 9 in Palmdale, Calif., the location of SOFIA’s home base at the Dryden Aircraft Operations Facility. Alvarez’s excitement partly originated from a childhood “NASA game” she played with her father. Alvarez’s now-deceased father taught her the names and locations of the constellations and talked about NASA research. She carried those memories aboard SOFIA, feeling her father’s presence.

Melvin Gorman and Gordon Serks of Chinle Junior High of Chinle, Ariz., joined Alvarez and Aguirre on the June 11 flight.

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Melvin Gorman and Gordon Serks of Chinle Junior High of Chinle, Ariz., joined Alvarez and Aguirre on the June 11 flight.
Success in New Zealand
SOFIA records milestones

Above, Bill Weiler, standing, Gabrielle Sauvage, seated, Alan Hatakeyama, and in the foreground is Helmut Wiesemeyer work during a mission. Above, SOFIA team members are pictured during the deployment at the Christchurch Airport. The mission was based at the airport where an outpost for the U.S. Antarctic Program that isn’t active in the area’s winter season was available. The U.S. Antarctic Program uses Christchurch as a staging area for sending people and supplies down to the McMurdo Station, which is a U.S. Antarctic research center.

At left, the Stratospheric Observatory for Infrared Astronomy NASA 747SP is parked on the ramp in Christchurch, New Zealand. The program had a successful first deployment to the Southern Hemisphere that included nine science missions in three weeks and achieved 100 percent of the science goals. Above, SOFIA team members are pictured during the deployment at the Christchurch Airport. The mission was based at the airport where an outpost for the U.S. Antarctic Program that isn’t active in the area’s winter season was available. The U.S. Antarctic Program uses Christchurch as a staging area for sending people and supplies down to the McMurdo Station, which is a U.S. Antarctic research center.

Michael Ritchson, from left, Rainer Strecker, standing and Stefan Teufel, seated, discuss options to best meet requirements for adding telescope documentation to the SOFIA portal database.
GREAT Science instrument is proving its value flight by flight

By Jay Levine

X-Press editor

As the Stratospheric Observatory for Infrared Astronomy redefines our knowledge of what is out in space, it will be key new instruments on its telescope that will make it happen.

One such instrument is the German Receiver for Astronomy at Terahertz Frequencies, or GREAT, which was installed on the NASA 747SP for the July deployment to Christchurch, New Zealand.

“The science was spectacular. The atmosphere was so dry that for many observations it was like being in space,” said Rolf Güsten, principal investigator for the GREAT instrument. Güsten, who is based at the Max Planck Institute for Radioastronomy in Bonn, Germany, referred to one of the key advantages of having an infrared telescope located in an airborne observatory — it is above the atmosphere that obscures infrared viewing from Earth.

“GREAT is not a camera, it is a spectrometer,” explained Urs Graf, a senior scientist at the University of Cologne, Germany. “We can look at the spectral distribution of the light that is coming in with very high accuracy and very high spectral resolution so we can identify individual types of molecules and atoms that are in space based on their spectral ‘fingerprint.’ To do this, we use technologies that are developed from radio frequencies all the way into the terahertz range and there are essentially no other instruments around that can do it.”

In addition to identifying molecules and atoms in space, high spectral resolution also can move the molecules and atoms away from researchers or toward them. Seeing chemistry and dynamics in space are the specialties of the GREAT instrument, Graf explained.

Prior to the New Zealand deployment, the GREAT instrument was enhanced. Designed in a modular way, the team can take advantage of the dramatic improvements in terahertz technologies and integrate them into the GREAT instrument.

“We have installed more sensitive detectors, more powerful oscillators which are needed to combine, or ‘mix’ the astronomical signal and much improved resolution bandwidth of the spectrometer that now provides more than 100,000 resolution elements per detector channel,” Güsten said.

What that means is the sensitivity of the instrument has almost doubled, which equals twice the science opportunities with better data at the same operation costs, Güsten explained.

Modifications have also enhanced the instrument in other ways. “Beyond its better sensitivities the improved GREAT has a wider reception bandwidth, allowing observations of signals from nearby galaxies like the Magellenic Clouds. For our deployment flights out of New Zealand we pushed our technological frontiers even further into new territories and higher frequencies, aiming at the detection of the unique hydrogen deuteride molecule. Deuterium, ‘heavy hydrogen,’ only produced in the Big Bang, serves as a chemical clock of the evolution of the universe,” Güsten explained.

“On Earth, deuterium accounts for only .02 percent of all hydrogen, carbon, in contrast, traces dense gas condensations with ongoing massive star formation and are still invisible at optical wavelengths.

The prominent star-forming cloud NGC603, a nursery for stars, is only visible from the Southern Hemisphere. GREAT observed the cloud in the sixth flight from Christchurch, New Zealand. The two images compare the far infrared sky to the optical view. The GREAT image shows the emission of ionized carbon as seen with GREAT (red is bright emission) compared with an optical image of the same region. The cluster of bright stars seen in the optical image is young – only a few million years old. The emission of the ionized carbon, in contrast, traces dense gas condensations with ongoing massive star formation and are still invisible at optical wavelengths.

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Senior Editor

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End of extract.
transient and cannot survive for long against the strong gravitational forces, ultimately feeding the black hole,” Güsten added.

Of the two molecules located in space with SOFIA, one is composed of sulfur and hydrogen and the other had oxygen and deuterium together. The New Zealand mission offered new opportunities for the GREAT instrument.

“The deployment was fabulously successful. We completed more than 25 science projects during this series of nine consecutive research flights. Heavy emphasis was placed on studies of the Large and Small Magellanic Clouds, which are close neighbor galaxies to the Milky Way, but only visible from the southern skies. They have been intensively studied at optical wavelengths, but there have been few opportunities to view the two dwarf galaxies that are widely unexplored at the far-infrared wavelength. GREAT advanced our knowledge about the star formation processes on galactic scales,” Güsten said.

Speaking of speaking, the instrument’s team is always thinking of ways to improve it. “With SOFIA, your instrument is never finished,” Graf said. “When your instrument is working, you already have ideas of how to improve it. No doubt GREAT and the stable of SOFIA instruments will continue to improve. As the instruments get more advanced, so too will the ability of researchers to collect information to answer key questions about the molecules and atoms that make up the cosmos. “I have been involved in many projects and I know the importance that teams understand science is the mission’s goal and Eddie (Gavala, SOFIA program manager) and his team are definitely committed to this,” Güsten said.

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Marcum expounds on questions about SOFIA's science

The Stratospheric Observatory for Infrared Astronomy, or SOFIA, excites many with its science exploits. Followers wonder about the science, what scientists are planning and how missions are chosen. Pam Marcum, SOFIA project scientist, answered some of these questions recently for X-Press editor Jay Levine.

As SOFIA project scientist, what are the main elements of your work?

As SOFIA project scientist I provide government oversight on the science of the mission. In particular, my primary responsibilities are to assure that the SOFIA mission meets its science requirements and that the commitments made to the science community are met. If any course adjustments are needed along the way, then my job is to develop recommendations to mitigate the problem and optimize SOFIA's science return. My position is probably best described as science advisor to the guy who holds the purse strings, the SOFIA program manager.

Can you give me a picture of the key upcoming flights over the next several years and what the main science objectives will be?

Curiously, no one on the SOFIA science team could ever know the answer to this question. The reason? Unlike some other NASA missions built with a laser-focused intent to answer a specific science question, SOFIA is a general observing facility built to address a wide range of science objectives. The astronomical community through an annual proposal competition drives the direction of SOFIA science.

The proposal evaluation is performed by review panels composed of astronomers drawn from the general community. Serving on a proposal review panel is somewhat the astronomer's equivalent of doing jury duty, but culminates in observing time being awarded to the guy who holds the purse strings, the SOFIA program manager.

Investigations is the modus operandi of nearly all large ground-based observatories and of most of the large space-based telescopes. Compared to these space-borne facilities, SOFIA's greatest advantage is that cutting-edge technologies can be incorporated into new science instruments and installed on SOFIA to help keep up with the rapidly expanding envelope of science knowledge. The space telescopes are largely stuck with the era of technologies that they were launched with and may not be able to keep up with the "latest and greatest" science returns. This approach, science one-year-at-a-time, is not unique to SOFIA. In fact, the annual evaluation/select science approach in measuring certain types of astrophysical phenomena, which includes a larger and more sensitive detector and the ability to measure polarization in astronomical targets, will significantly increase the science capabilities of this instrument. HAWC, which has been promoted to second-generation instrument status, is now known as "HAWC+" and will be commissioned during Cycle 3 in 2015.

Are you pleased with the science achieved with the SOFIA so far?

Extremely pleased. The quick turnaround of the aircraft and observatory was executed in a flawless manner, with all systems working well and supporting each other. The first attempt at this higher flight rate was tremendously successful!

Two SOFIA instruments have not yet flown. I presume that's because they are still in development. What is the status of the Echelon-Cross-Echelle Spectrograph, also known as the UC Davis-developed EXES, and the JPL High-resolution Airborne Wideband Camera, or HAWC?

The EXES instrument is completing its development and will be commissioned and used for observations by the science community during Cycle 2 in 2014. HAWC was a first-generation instrument that was selected for major overhaul during the second-generation science instrument selection process. This upgrade, which includes a larger and more sensitive detector and the ability to measure polarization in astronomical targets, will significantly increase the science capabilities of this instrument. HAWC, which has been promoted to second-generation instrument status, is now known as "HAWC+" and will be commissioned during Cycle 3 in 2015.

Are you pleased with the science achieved with the SOFIA so far?

To answer this question, let's review the science products from SOFIA to date. Analysis from the first set of science flights from November 2010 to December 2011, dubbed "Early Science," has resulted in more than 30 journal publications. Some of those papers describe new approaches in measuring certain types of astrophysical phenomena, utilizing mid-infrared images taken at unprecedented resolution, and announcing at least two "firsts" in the observation of particular molecules in interstellar space.

The science observations completed during Cycle 1 will most certainly have a similar science return in the form of published results. I am pleased with the results to date, especially considering the fact that the telescope still was in development when these data were acquired and therefore was not at the peak performance it will be operating.
It’s a challenge to keep a telescope pristine and ready to make new discoveries when it’s located on the Stratospheric Observatory for Infrared Astronomy and flying at altitudes up to 45,000 feet. A door in the side of the massive NASA 747SP that houses the telescope opens during missions, which is one reason that housekeeping chores can pile up. “It’s like dusting your house – it never ends,” said Geoffrey Ediss, a SOFIA engineer lead. 

Studies with SOFIA’s telescope and instruments are expected to give new perspective on the universe, but to do that it’s vitally important to have the telescope mirrors clean. Ediss said. “We just ‘washed’ the mirror that left stain marks. As parts of the telescope shrink, so we measure temperature,” Ediss explained. “The imager works by splitting the visible light from the same objective. The imager improvements allow for better visibility of fainter objects and a larger area of the sky to line up what is seen with the science objective. The imager works by splitting off the visible light from the same spot in the sky and putting that into a charged-coupled device, or CCD, camera,” Ediss explained. “The imager improvements allow for better visibility of fainter objects and a larger area of the sky to line up what is seen with the science objective. The imager works by splitting off the visible light from the same spot in the sky and putting that into a charged-coupled device, or CCD, camera,” Ediss explained. “The imager improvements allow for better visibility of fainter objects and a larger area of the sky to line up what is seen with the science objective. The imager works by splitting off the visible light from the same spot in the sky and putting that into a charged-coupled device, or CCD, camera,” Ediss explained. “The imager improves...
By Jay Levine  
X-Press editor

When it absolutely, positively has to be ready to go, whom do you call?

When the location was New Zealand and the platform was the Stratospheric Observatory for Infrared Astronomy, Daryl Townsend had the answers for the aircraft. Townsend, SOFIA aircraft maintenance and logistics chief, had the responsibility of keeping the NASA 747SP ready to fly.

It was the SOFIA program’s first deployment to the Southern Hemisphere where the focus was on astronomical phenomena that can’t be seen well – or at all – from the Northern Hemisphere. However, plans were put to the test July 17 when an aircraft system failed that required the rapid delivery of equipment and personnel.

Enter Matt Reaves, who is the SOFIA platform lead instrumentation engineer. When the call came that there was trouble, he headed down to the outpost in Christchurch, New Zealand.

“I had three laptops shipped to meet me in Christchurch that could provide alternate methods of real-time data monitoring. After we found the best locations to place the two required laptops, the avionics technician crew did an exceptional job installing them,” Reaves explained.

logistics

Everything must be ready for the mission to succeed

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The logistics staff members must have invested in a 55-gallon barrel of pain relievers, as it’s not simple to plan for parts and people to travel halfway around the world. Logistics plans were detailed to cover anticipated challenges and fortunately, Townsend said, there were few major challenges that required items that were not on hand. Had there been those kinds of issues, the logistics plan included expedited shipping, vendors to tap and methods to pay for it quickly. Townsend also credited Valerie Jones, SOFIA maintenance logistics lead and Rosalia Toberman, Dryden Aircraft Operations Facility procurement officer lead, for invaluable work on logistical support.

“We have certain parts identified during the flying observatory’s return from a 10-hour mission,” Reaves explained. “So, when the SOFIA team returns this year of flying up to four missions a week, Toberman said. “It takes a lot of coordination with a lot of people,” he said.

A non-stop trek from Los Angeles International Airport to New Zealand is roughly 12 hours of flying, he said. Crossing the International Date Line means passengers land in New Zealand tomorrow and return to the U.S. on the same day as they depart from New Zealand.

The observatory and its staff will be challenged as the number of flights and the varied science gears up, but this mission shows that the team is ready for these challenges.