National Aeronautics and Space Administration

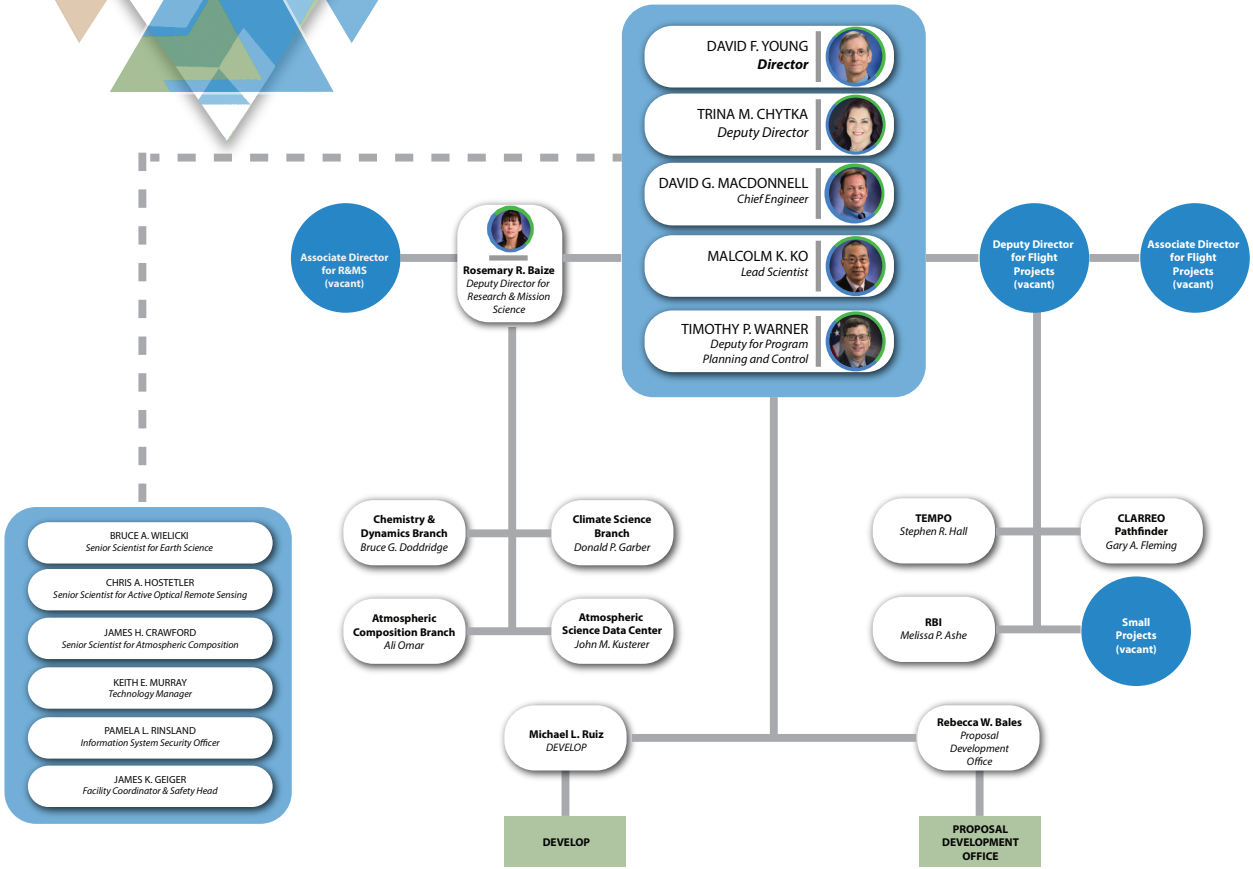
Annual Report 2018

The Science Directorate at NASA's Langley Research Center

TABLE of CONTENTS

- ORGANIZATIONAL CHART
- DIRECTOR'S MESSAGE
- 2018 QUARTERLY TIMELINE
- SD SATELLITES
- FEATURE HIGHLIGHTS
- PHOTO HIGHLIGHTS
- FY18 METRICS

THE SCIENCE DIRECTORATE
at NASA'S LANGLEY RESEARCH CENTER



LETTER from the **DIRECTOR**

It is my pleasure to present NASA Langley Research Center's Science Directorate (SD) 2018 Annual Report. This report includes research highlights from Calendar Year 2018 and organizational metrics from Fiscal Year 2018.

Our research is focused on four main areas: Air Quality, Radiation and Climate, Atmospheric Composition and Active Remote Sensing. Our researchers are involved in a number of scientific initiatives including advanced instrument development, field and space-borne experiments and data retrieval, analysis and archival. We take significant pride in our robust Applied Science programs, and our commitment to sharing scientific data through the Atmospheric Science Data Center. We further extend the reach of our research to the public through our efforts in Communication, Education and Public Engagement.

The past year brought organizational changes as we finalized the incorporation of the project management of science projects into SD. This merger has resulted in a closer integration of science with instrument development, improved communication with our stakeholders, and a rigorous project execution culture tailored to the needs of the Science Mission Directorate.

We've worked to produce key Earth Science data records from several satellite atmospheric monitoring instruments developed at Langley. After launch and robotic installation to the International Space Station in 2017, the SAGE III science team successfully validated data gathered to study ozone and aerosols in the stratosphere. Launched in December 2017, the CERES Flight Model 6 scanned Earth for the first time, joining five other operational CERES instruments to extend a critical climate data record begun in 1997. SABER continues to find new purpose as it assists with identifying Earth-like planets in habitable zones. In its 12th year of operation, CALIPSO successfully maneuvered from the A-Train to the C-Train where it rejoined its sister satellite, CloudSat, in their joint pursuit of measuring the vertical structure of clouds.

In 2018, the TEMPO instrument was successfully delivered and it now awaits the selection of a launch host. Langley's legacy of Earth Science continues with the development of an instrument of unprecedented accuracy under the CLARREO Pathfinder project. NASA also announced ACTIVATE, a five-year Langley-led airborne project to study aerosols and changing clouds.

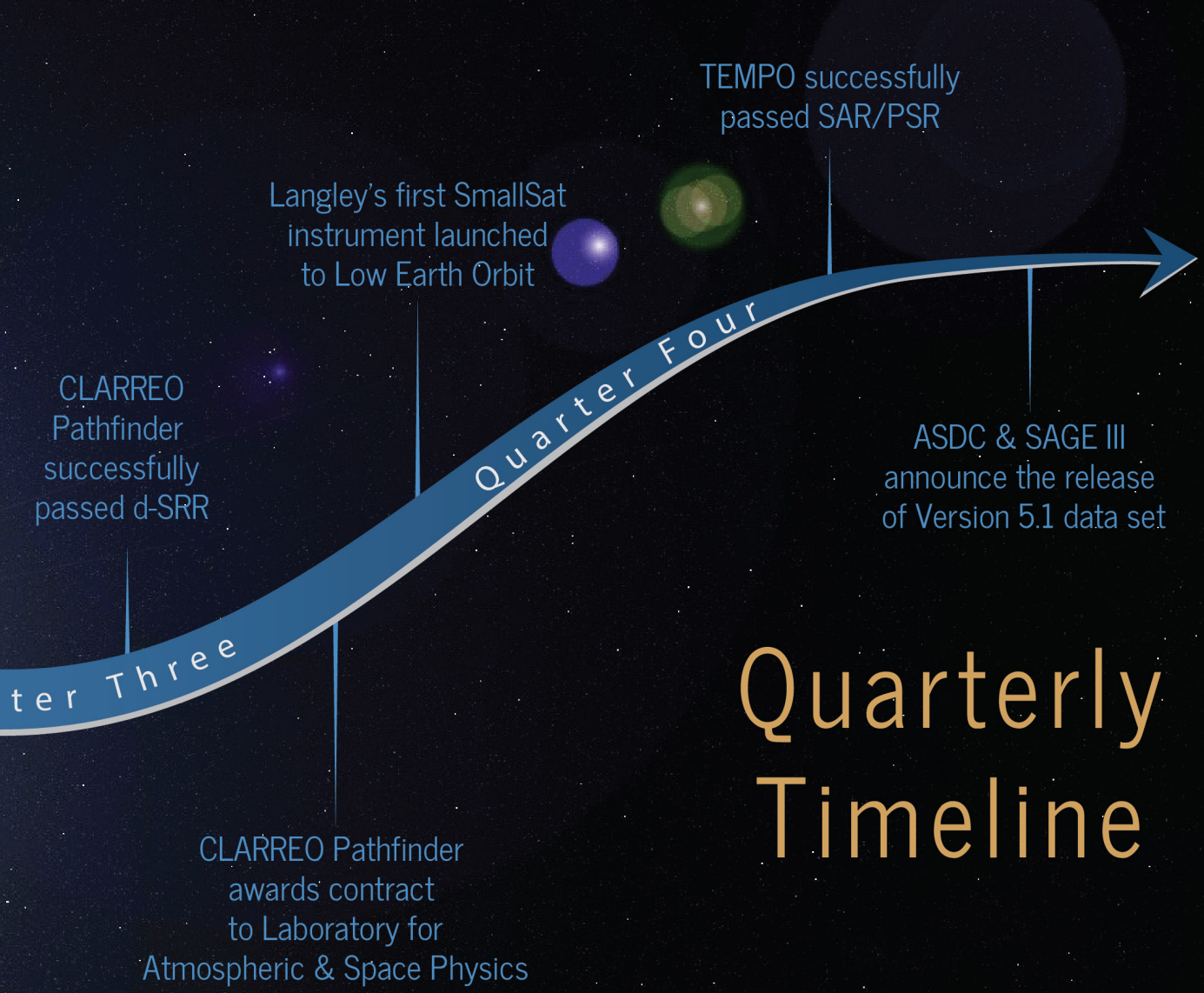
Langley's first SmallSat instrument, The Rapid Response Radiation Survey, or R3S, launched to Low Earth Orbit as part of Spaceflight Industries' SSO-A: SmallSat Express, an organized rideshare that will deposit multiple satellites into a sun synchronous polar orbit. We continue to develop innovative and cost-efficient ways to maintain long-term data records with SmallSats like SAGE IV.

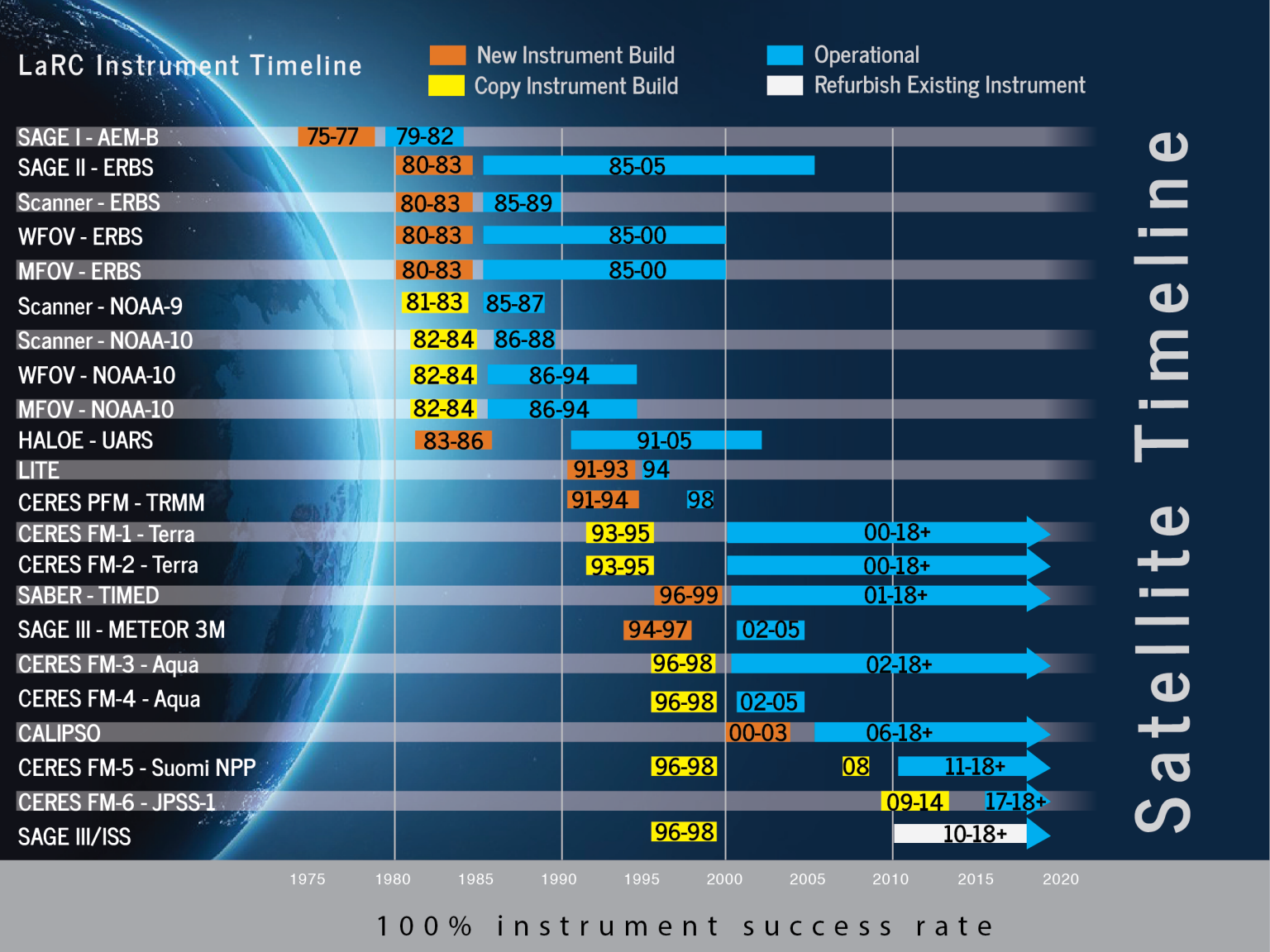
Approximately 300 civil servant and contractor scientists and support personnel serve as the backbone of the Science Directorate, and are the reason we consistently advance research that leads to a safer planet and better tomorrow.

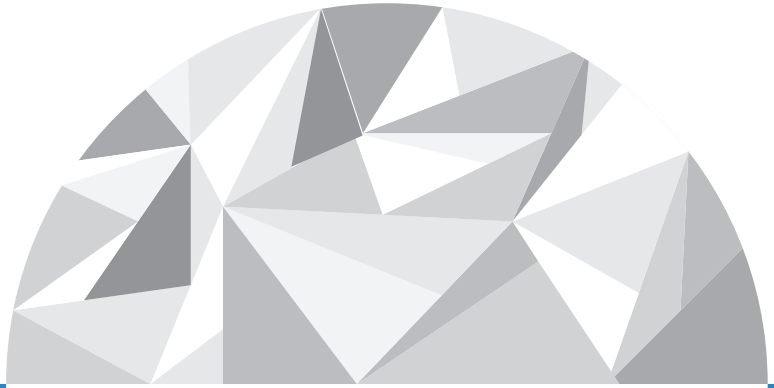
David F Fuig


CERES FM6 scans Earth for the first time
SAGE III successfully validates data to study ozone
TEMPO successfully undergoes thermal vacuum testing
Quarter One
Quarter Two
Quar
First set of lunar data collected from SAGE III
2018
CALIPSO successfully maneuvers from the A-Train to the C-Train

Quarterly Timeline

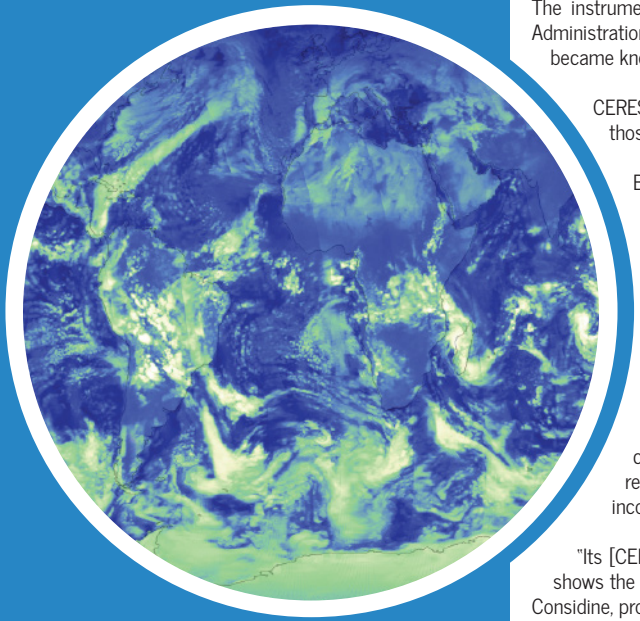



LaRC Instrument Timeline
New Instrument Build
Copy Instrument Build
Operational
Refurbish Existing Instrument
SAGE I - AEM-B
75-77
79-82
SAGE II - ERBS
80-83
85-05
Scanner - ERBS
80-83
85-89
WFOV - ERBS
80-83
85-00
MFOV - ERBS
80-83
85-00
Scanner - NOAA-9
81-83
85-87
Scanner - NOAA-10
82-84
86-88
WFOV - NOAA-10
82-84
86-94
MFOV - NOAA-10
82-84
86-94
HALOE - UARS
83-86
91-05
LITE
91-93
94
CERES PFM - TRMM
91-94
98
CERES FM-1 - Terra
93-95
00-18+
CERES FM-2 - Terra
93-95
00-18+
SABER - TIMED
96-99
01-18+
SAGE III - METEOR 3M
94-97
02-05
CERES FM-3 - Aqua
96-98
02-18+
CERES FM-4 - Aqua
96-98
02-05
CALIPSO
00-03
06-18+
CERES FM-5 - Suomi NPP
96-98
08
11-18+
CERES FM-6 - JPSS-1
09-14
17-18+
SAGE III/ISS
96-98
10-18+
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Satellite Timeline
100% instrument success rate



FEATURE **HIGHLIGHTS**

'FIRST LIGHT' IMAGES FROM CERES FM6 EARTH-OBSERVING INSTRUMENT



"It is the most accurate broadband radiometer that NASA/NOAA have flown as a result of a more rigorous prelaunch calibration campaign than previous instruments"

It's working!

On Jan. 5, 2018, the covers on the Clouds and the Earth's Radiant Energy System Flight Model 6 (CERES FM6) opened, allowing it to scan Earth for the first time.

The instrument was one of five that launched Nov. 18, 2017, on the National Oceanic and Atmospheric Administration's (NOAA) Joint Polar Satellite System 1 (JPSS-1). After reaching polar orbit Nov. 18, the satellite became known as NOAA-20.

CERES FM6 began scanning Earth at approximately 1:25 p.m. on Jan. 5. On Jan. 10, scientists used those scans to produce the "first light" images.

Built by Northrop Grumman, funded by NOAA, and managed by NASA's Langley Research Center in Hampton, Virginia, in coordination with the JPSS program, CERES FM6 is the seventh in a series of instruments that support NASA's continuing goal to understand and measure the solar energy reflected by Earth, the heat the planet emits, and the role of clouds in that process.

"CERES FM6 is the seventh and final copy since we first launched the first CERES instrument in 1997," said CERES Project Scientist Kory Priestley. "It is the most accurate broadband radiometer that NASA/NOAA have flown as a result of a more rigorous prelaunch calibration campaign than previous instruments."

In the shortwave image from CERES FM6 to the left, the white and green shades represent thick cloud cover reflecting incoming solar energy back to space. Compare that with the darker blue regions, which have no cloud cover, to get a sense of how much clouds can affect the balance of incoming and outgoing energy on Earth.

"Its [CERES] data will help us to understand the critical role that clouds play in the Earth system, and shows the value to the nation of the NASA and NOAA collaboration leading to this achievement," said David Considine, program manager for NASA's Modeling, Analysis and Prediction program, and Program Scientist for the CERES instruments on the Terra, Aqua, and NPP-Suomi satellites.

Five other CERES instruments are flying on three other satellites. Prior to CERES, the Earth Radiation Budget Experiment (ERBE) collected similar data beginning in 1984.

"Between the seven CERES instruments and their ERBE predecessors, we have had a relationship in Earth radiation budget measurements that now spans over three decades," said Northrop Grumman CERES Program Manager Sean Kelly.

Originally published on: Jan. 16, 2018

A LIFELONG COMMITMENT TO EARTH SCIENCE KNOWLEDGE AND DATA

In 1978, an international team of scientists was selected from proposals to an Announcement of Opportunity to participate in the design and development of the Earth Radiation Budget Experiment (ERBE). Dr Bruce Barkstrom of NASA Langley was selected as the ERBE Principal Investigator. He led the team through 30 meetings to guide the development of the instrumentation and the ground processing software for analyzing the data.

Barkstrom recalled the very first ERBE science team meeting, which involved a full day of attempting to determine exactly where the top of the atmosphere was. After much debate, they assigned one person at NASA Langley, to develop the number, which ended up being about 18 miles (30 kilometers) above the sphere that forms the Earth.

"That was the level of detail we had to get into as a science team," Barkstrom said.

In October 1984, ERBE launched aboard NASA's Earth Radiation Budget Satellite (ERBS) from the space shuttle Challenger (STS-41G).

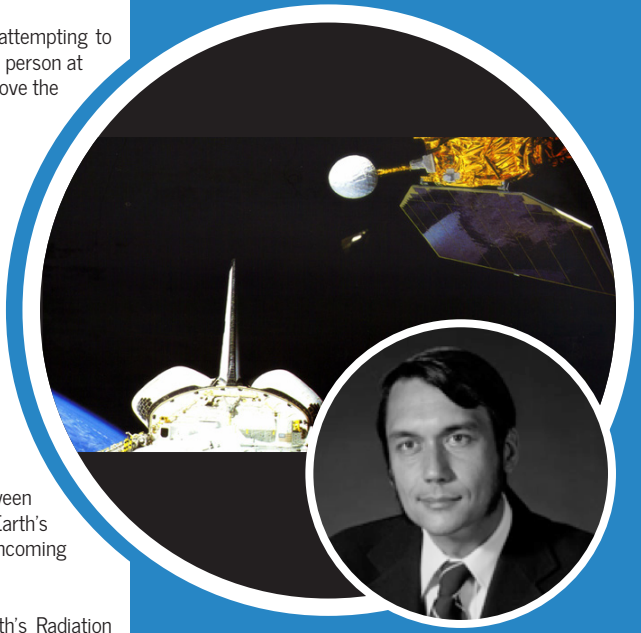
"We had to get up at 3:30 a.m. to watch the ERBS launch at 7:30 a.m., and what I remember about that particular morning was that we had an overcast sky. And when the shuttle lit up, it was such a bright exhaust that it lit up the whole sky from underneath," Barkstrom recalled. "And then, of course, the shuttle went through the clouds, and the light dimmed, and probably about a minute later the sky lit up again because the sun was reflected off the exhaust.

"It's impossible for me to describe this without getting a little emotional."

For 10 years, ERBE provided invaluable data for scientists studying the energy interactions between the Sun, clouds and Earth. Its satellite measurements have provided new information on Earth's radiation at the top of the atmosphere, including the important radiative effects of clouds on incoming and outgoing energy in the overall process.

Far beyond that, Barkstrom continued to expand our knowledge and understanding of Earth's Radiation Budget and making that data accessible to others. He was instrumental in developing data formats for the CERES experiments, was the main architect of NOAA's scientific data stewardship project, a precursor to the Climate Data Records (CDR) program, and he developed a cost model for EOSDIS.

During his career, Bruce authored or coauthored 117 publications with 5,323 citations. Of these, 37 have been ranked as highly influential by Semantic Scholar. Dr. Bruce Barkstrom passed away on April 1, 2018. His contributions will remain foundational for NASA's Earth Energy Budget research and data.



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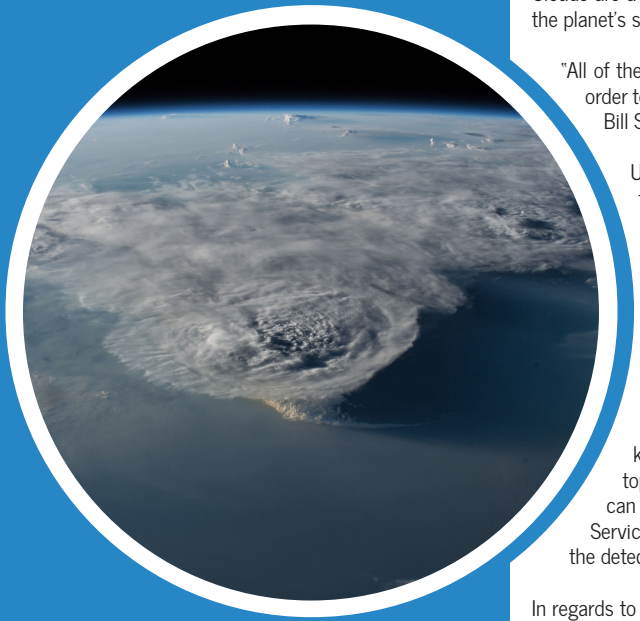
HOW CLOUD DATA IS IMPROVING WEATHER FORECASTS



"The NASA Langley products from SatCORPS provide unique coverage of cloud information that are used in NOAA operational hourly-updating weather forecast models to help produce cloud ceiling forecasts..."

NASA Langley Research Center's Satellite Cloud and Radiative Property Retrieval System (SatCORPS) team takes cloud imagery from NOAA's Geostationary Operational Environmental Satellite system (GOES) and feeds the resulting knowledge and products back to NOAA, sharpening daily weather forecasts.

Clouds are a key player in Earth's weather, reflecting incoming sunlight and trapping heat emanating from the planet's surface.

"All of these effects depend on the physical properties of clouds, which must be properly diagnosed in order to accurately predict their impacts with weather forecast models," said NASA Langley researcher Bill Smith, who, along with fellow researchers Louis Nguyen and Kris Bedka, leads SatCORPS.

Using imagery from GOES and other satellites, the algorithms developed by SatCORPS can piece together key information on clouds, such as their altitude, thickness, density and whether they're composed of ice crystals, liquid water, or both.

"The NASA Langley products from SatCORPS provide unique coverage of cloud information that are used in NOAA operational hourly-updating weather forecast models to help produce cloud ceiling forecasts that are critical for a variety of stakeholders including the aviation community," said Curtis Alexander, acting chief of the Assimilation Development Branch at NOAA's Earth System Research Laboratory.

SatCORPS uses the data products from satellite imagers such as GOES-S to help improve knowledge of severe thunderstorms. A key indicator of a severe thunderstorm is an overshooting top, pictured to the left. Using a process that incorporates GOES imagery, the SatCORPS team can spot overshooting tops and provide thunderstorm detection products to the National Weather Service (NWS) in near real-time. The team is also working with the University of Oklahoma to improve the detection and prediction of tornadic storms.

In regards to aviation safety, when an aircraft encounters icing due to supercooled liquid water in clouds at below-freezing temperatures, or high concentrations of small ice crystals, control problems and jet engine malfunctions can occur. SatCORPS has developed satellite-based icing products for these aviation conditions which are provided to the NWS for evaluation in aviation weather forecasting operations.

"The benefits of these data in SatCORPS...will improve forecasts and potentially lead to better protection of life and property," Bedka said.

Originally published on: March 7, 2018

SAGE III SCIENCE DATA VALIDATION EFFORTS BEGIN

An orbiting science instrument whose legacy dates back 34 years continues to beam back data on Earth's protective ozone layer – this time, from a perch on the hull of the International Space Station. Since March 2017, the Stratospheric Aerosol and Gas Experiment III (SAGE III) instrument has been measuring and collecting data on Earth's sunscreen, stratospheric ozone, as well as other gases and aerosols.

The SAGE III instrument makes measurements using well-proven remote sensing techniques –another way of saying that data is collected some distance away from the instrument installed on the ISS – which requires confirmation of the data accuracy.

To do this, SAGE III science data is compared to in-situ measurements of ozone, water vapor, and aerosols collected by the Network for Detection of Atmospheric Composition Change (NDACC), an international group composed of scientists and research sites across the world collecting data on the Earth's atmosphere.

"These sites have been vetted, validated, and have a long statistical history of making science measurements with their instruments," said SAGE III Science Manager Marilee Roell.

The NDACC will collect these validated measurements through various methods, with two primary methods being through lidar and balloon sondes.

The science validation team is using NDACC ozone and aerosol lidar data, as well as ozone and water vapor sonde measurements, to validate science data collected from SAGE III.

"We match our vertical science product to an externally validated source. It helps the science community have confidence in our data set," said Roell.

The team is working to validate science data with NDACC locations in Boulder, Colorado and Lauder, New Zealand, which fall within similar latitude bands in the northern and southern hemispheres. To be precise in validation efforts, the lidar or sonde measurement is taken at the same time and location that SAGE III is passing over and collecting equivalent data.

Validation efforts were taken a step further by including a third source of measurements: NASA's DC-8 aircraft. The aircraft helps validate the accuracy of other remote-sensing satellite data, such as SAGE III, and can fly under the satellite's path to collect the same measurements.

The SAGE III validation website displays instrument overpasses of NDACC sites that are three weeks out or less. The SAGE III validation team is pursuing additional NDACC sites to coordinate overpass timeframes.

Originally published on: March 28, 2018

"We want to match our vertical science product to an externally validated source. It helps the science community have confidence in our data set."

TINY CREATURES HOLD SECRETS TO EARTH'S CLIMATE

Findings from three deployments have already confirmed a distinct shift in the annual cycle of the phytoplankton bloom and a clear lack of larger-sized plankton during the peak of the bloom.

NASA's North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) mission began its fourth and final deployment, making it the first research mission to conduct an integrated study of all four distinct phases of the world's largest phytoplankton bloom in the North Atlantic and how they impact the atmosphere.

"Most scientists studying the bloom head to sea during its climax in late spring and early summer. We did that, but we also went out during the other seasons to fully capture the minimum and transitions of the bloom." said NAAMES Deputy Project Scientist Rich Moore from NASA Langley.

NAAMES research challenges traditional ideas about bloom dynamics and species succession. Findings from three deployments have already confirmed a distinct shift in the annual cycle of the phytoplankton bloom and researchers have noted a clear lack of larger-sized plankton during the peak of the bloom. The implication of these findings will be presented in a series of journal publications over the coming year.

"This thoroughness pays off as our ship-based scientists use these data to fully describe the entirety of the plankton bust/boom cycle," Moore said. "No one has done this before, and we're excited about the science findings that are beginning to trickle out now."

During previous NAAMES deployments, researchers completed 220 research hours aboard an instrumented C-130 aircraft along specific tracks and maneuvers over the North Atlantic, including fly overs of the Woods Hole Oceanic Institute's (WHOI) Research Vessel Atlantis, which carries more than 50 researchers and crew members.

Plankton ecosystems of the global ocean profoundly affect climate and life on Earth. NASA's ocean color satellite record tells us that these invaluable ecosystems are highly responsive to climate variability, with changes in ocean production impacting food production, uptake of atmospheric carbon dioxide, and emission of climate-regulating aerosols.

Our ability to predict consequences of a warming ocean and develop realistic mitigation and adaption strategies depends on resolving conflicting hypotheses regarding the factors controlling plankton ecosystems and biogenic aerosol emissions.

Originally published on: April 19, 2018

THE NEXT GENERATION OF NASA'S SAGE MISSION

It's science in a shoebox.

The Stratospheric Aerosol and Gas Experiment IV (SAGE IV) Pathfinder is the next generation in a line of instruments that have been monitoring stratospheric ozone, aerosols, and trace gases for over four decades. Over the years, these instruments have collected data on the decline of ozone in the Earth's atmosphere and have hinted at a potential recovery in the ozone hole. The SAGE IV instrument will maintain the long-term data record of measurements monitoring the Earth's atmosphere, but in an innovative and cost-efficient way.

"We have been able to take the knowledge gained over the decades to constantly improve the system and make a better measurement, and now we can do it for less money and with technology that's commercially available," said SAGE IV Co-Principal Investigator Robert Damadeo of NASA's Langley Research Center.

Compared to the kitchen stove-sized SAGE III instrument making measurements from the International Space Station, the SAGE IV solar occultation imager will be the size of a large shoebox. The SAGE III/ISS instrument makes its occultation measurements by scanning the sun back and forth within a small field of view each time. With its simplified measurement technique and hardware, SAGE IV will have the capability to capture an image of the entire sun eliminating major technological and algorithmic challenges that were present in previous solar occultation instruments which only captured portions of the sun.

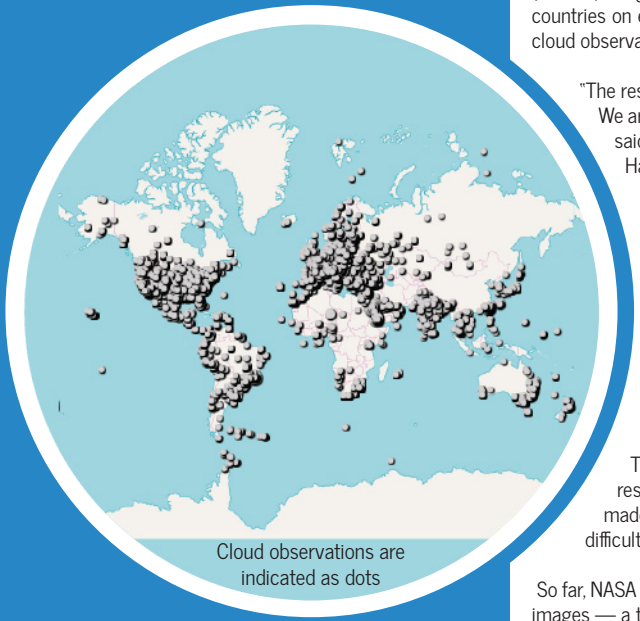
To date, there has not been a radiometric solar occultation imager.

SAGE IV is a part of the NASA Instrument Incubator Program (IIP) under the NASA Earth Science Technology Office. Scientists at NASA Langley are working to build and test a ground demonstration unit.

"We have been able to take the knowledge gained over the decades to constantly improve the system and make a better measurement, and now we can do it for less money and with technology that's commercially available."

Originally published on: April 22, 2018

NASA TO CLOUD-GAZING CITIZEN SCIENTISTS: JOB WELL DONE



Cloud observations are indicated as dots

During the month-long challenge period, GLOBE received just over 56,000 cloud observations from more than 15,000 locations in 99 countries on every continent, including icy Antarctica.

Give yourselves a pat on the back, citizen scientists! If the results from the GLOBE Cloud Observation Challenge between March 15 and April 15 are any indication, you certainly earned it.

During the month-long challenge period, the Global Learning and Observations to benefit the Environment (GLOBE) Program, received just over 56,000 cloud observations from more than 15,000 locations in 99 countries on every continent, including icy Antarctica. This far surpassed GLOBE's last major influx of 19,000 cloud observations received for the Aug. 21, 2017, total solar eclipse.

"The response to the data challenge has been beyond belief and has excited so many scientists at NASA. We are particularly excited to have received so many observations from different countries and regions," said Marilé Colón Robles, lead for the GLOBE Clouds team at NASA's Langley Research Center in Hampton, Virginia. "We want to extend a very sincere thank you to everyone who made observations."

More than 27,000 new users registered for the GLOBE Observer app during the challenge, compared to 1,800 the month before.

The numbers were so big — more than 10 times the usual number of new observations and users — GLOBE had to double its server capacity.

GLOBE cloud data is useful for a wide range of science, such as helping researchers validate observations from a suite of six satellite instruments known as the Clouds and the Earth's Radiant Energy System (CERES).

Though the CERES instruments use advanced technology, some cloud types aren't easy for researchers to identify from space — thin, wispy cirrus clouds, for instance. By matching observations made on the ground to images from satellites, scientists can make positive identifications of those difficult-to-identify clouds.

So far, NASA has matched more than 30,000 citizen science observations from the Cloud Challenge to satellite images — a treasure trove of data to be explored. And researchers hope the data will continue to pour in.

"We encourage everyone to keep submitting cloud observations every day and throughout the year, because these observations matter," said Colón Robles.

The GLOBE Program sends a special thank you to the super observers from Poland, Croatia, Hungary, Saudi Arabia, India, Brazil, the United States, and South Africa.

Originally published on: April 23, 2018

HELP FROM ABOVE: NASA AIDS KILAUEA DISASTER RESPONSE

On May 3, the Kilauea volcano on Hawaii's Big Island erupted from new fissures and sent lava flowing over streets and neighborhoods. As the disaster response on the ground lead by the U.S. Geological Survey (USGS) kicked into gear, managers from NASA's Earth Science Disasters Program sent out a call to NASA's own researchers, data managers, and satellite teams: What can we do to help?

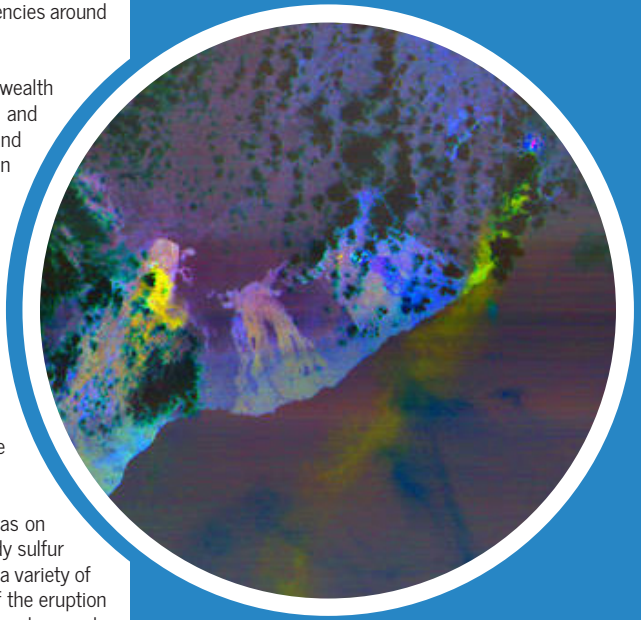
With an array of sophisticated Earth-observing sensors in orbit, and partnerships with space agencies around the globe, NASA had a lot of assets to offer.

The NASA Disasters Team, which includes several researchers from NASA Langley, provided a wealth of satellite and airborne products to support USGS. This included satellite visible, infrared and Synthetic Aperture Radar (SAR) data imageries to monitor ground deformation, lava flows and their impacts on local population with a specific focus on the Leilani state area where more than 700 houses got destroyed and 2,000 people were evacuated.

A dedicated field campaign deployed quickly in Hawaii using the In SAR airborne instrument (GLISTEN) to map out the lava fields and produce data for models to estimate the expected duration of the eruption based on the size of the magmatic chamber and volume of lava spilled out.

"In addition, the impacts of the eruption on aviation and air quality were assessed using satellite images in the UV-Vis to detect the presence of sulfur dioxide in the atmosphere, the vertical extent of the volcanic clouds and how it impacted pollution on the ground," said Jean Paul Vernier of NASA Langley. "CALIPSO was used to assess the vertical extension of the plume but MSIR provided the most useful information due to its larger swath."

Within 15 days after the Kileaua eruption, the Volcano Rapid Response (VolKilau) Campaign was on the ground at Hawaii's Big Island, just downwind of fissures and the Halemaumua crater to study sulfur dioxide and aerosol emissions from the Kilauea eruption. The NASA Langley-led team deployed a variety of balloon measurement payloads just downwind from the eruptive vents to assess the impact of the eruption on air quality and improve model simulations, validate satellite observations of sulfur dioxide and aerosols and to better prepare for the next large volcanic eruption.



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Originally published on: May 21, 2018

SPRINGING BACK INTO THE HUNT FOR GREENHOUSE GASES

ACT-America flights provide first-time data about spring storms with the specific goal of mapping out carbon transport.

A NASA airborne science study looking at the transport of two major greenhouse gases in the eastern half of the U.S. just completed its fourth and next-to-last flight campaign. By measuring how weather systems move carbon dioxide and methane, Atmospheric Carbon and Transport-America, or ACT-America, aims to improve our understanding of where the gases originate and where they're being absorbed.

Flight campaigns have covered summer, fall, winter and spring. A final set of flights in 2019 will take a second look at summer, which is a particularly active time for greenhouse gas transport. ACT-America flights provide first-time data about spring storms with the specific goal of mapping out carbon transport.

Flight plans are designed to measure carbon dioxide, methane and stormy weather patterns. The team is able to map out focused areas of study based on existing scientific data from towers and previous instrumented flights. For example, in the hunt for methane, coastal wetlands are of particular interest to ACT-America scientists because there's a lot of uncertainty around how much methane they produce.

During these campaigns, the team has researched local variations of greenhouse gases over North America, as well as the large scale flow of air. They are learning about the inter mixing processes of global air, and how much carbon dioxide and methane is present as a storm moves.

"ACT-America is a really focused data set that I hope people will look back on and think of as a really important turning point in our understanding of greenhouse gases, their transport and all of the uncertainties involved in that process across the United States," said Mike Obland, ACT-America Project Manager from NASA Langley.

Originally published on: June 1, 2018

NASA JOINS EFFORT TO SNIFF OUT OZONE IN THE NORTHEAST

The Long Island Sound — a region known for its coastal communities, beaches, and fishing. But it's also a region where noxious emissions, meteorology and the water-land transition open the door to an unwanted guest — ozone. Ozone diminishes air quality, aggravates breathing problems, and can even cause lung damage.

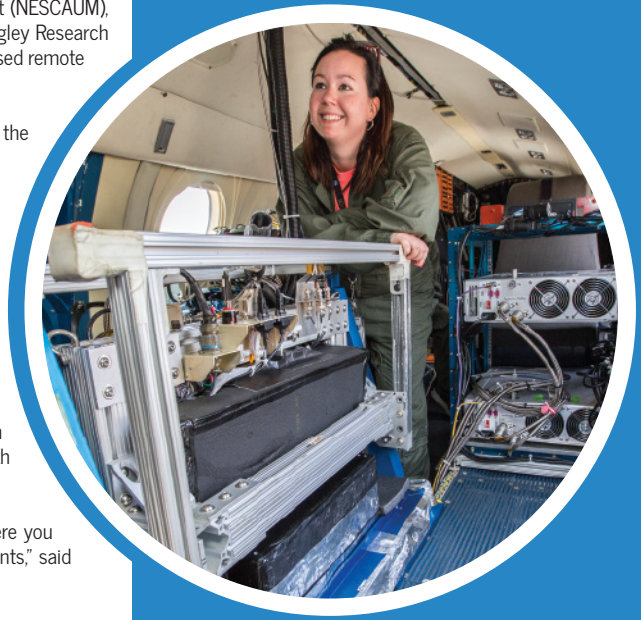
The good news is, a scientific investigation is looking into how that troublesome ozone forms and how it's being transported around the sound. Led by the Northeast States for Coordinated Air Use Management (NESCAUM), the Long Island Sound Tropospheric Ozone Study (LISTOS) kicked off in June 2018. NASA's Langley Research Center and Goddard Space Flight Center are contributing scientists, pilots, aircraft and aircraft-based remote sensing instruments to the effort.

Other NASA studies of ozone such as OWLETS-2 also participated in LISTOS by studying ozone in the northern Chesapeake Bay.

"The meteorology of these areas in one way or another accentuates getting the high ozone," said Jay Al-Saadi, LISTOS platform scientist at Langley.

Airflow and heat have everything to do with high ozone concentrations. Land-water breezes can concentrate ozone along the coastline. Heat accelerates ozone production.

LISTOS will employ multiple instruments including Goddard's Geostationary Trace gas and Aerosol Sensor Optimization (GeoTASO), pictured to the right, a remote-sensing instrument that measures atmospheric trace gases and aerosols and serves as a test bed for a future NASA mission called Tropospheric Emissions: Monitoring of Pollution (TEMPO). Scheduled to launch on a commercial satellite within a few years, TEMPO will monitor major air pollutants across North America hourly.



"We're getting these TEMPO-like measurements at different times of day in field intensives where you have partners that are making the other measurements that you need to truth our measurements," said Al-Saadi.

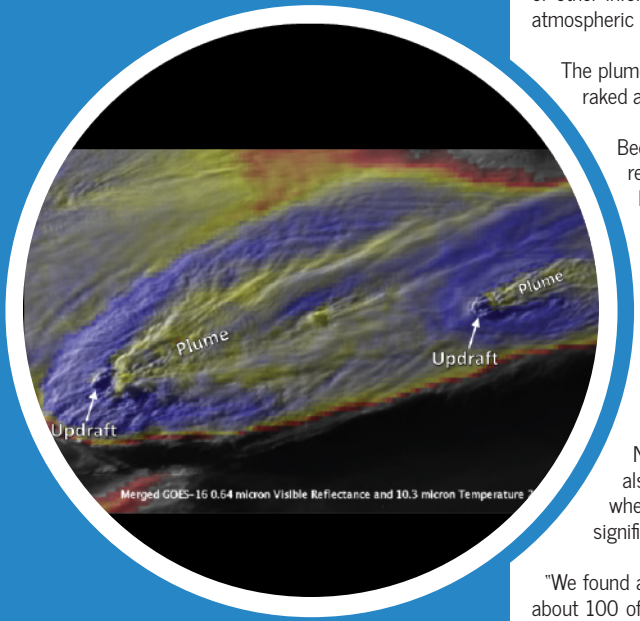
LISTOS will also employ a new Langley instrument called the High Altitude Lidar Observatory (HALO) which uses laser pulses to measure atmospheric gases and aerosols. Langley and Goddard will also contribute ozone-measuring ground lidar systems that are part of NASA's Tropospheric Ozone Lidar Network (TOLNet). The Langley team hopes state and federal partners will be able to turn the measurements into actionable data.

"It always gets back to what can we do to help improve the air quality, to curtail the emissions?" said Al-Saadi.

Originally published on: June 25, 2018

"It always gets back to what can we do to help improve the air quality, to curtail the emissions?"

SEVERE STORMS SHOW OFF THEIR "PLUME-AGE



"We found about 400 plume-producing storms across 13 severe weather outbreaks, and in about 100 of them you had a plume appearing 10 minutes before the first warning, potentially providing additional lead time for saving lives and property"

Easily identifiable in satellite imagery, the Above Anvil Cirrus Plume, or AACP, looks like a plume of smoke emanating out from the top of what, in all likelihood, is a serious storm.

"The plume pattern in the imagery instantly tells you without the need for radar or lightning observations or other information that these are the storms you really, really need to look out for," said Kris Bedka, an atmospheric scientist at NASA's Langley Research Center in Hampton, Virginia.

The plumes have been a frequent sight over the U.S. this summer as outbreaks of severe weather have raked across the Midwest, bringing high winds, tornadoes and hail with them.

Bedka is studying the AACP phenomenon with colleagues at the University of Oklahoma. Their research is showing that compared to non-plumed storms, plumed storms are significantly more likely to produce high winds, major tornadoes and large hail. In addition, their findings could help weather forecasters provide earlier warnings of severe and tornadic storms not just in the U.S. but around the world.

Over the course of their research, Bedka and his colleagues identified hundreds of plumed storms over the U.S. using highly detailed imagery collected at one-minute intervals by the National Oceanic and Atmospheric Administration's Geostationary Operational Environmental Satellite System, specifically GOES-14 and GOES-16. They then determined when the plumes first formed, how long they lasted and when they decayed.

Next, they linked that satellite data to radar and lightning data from the same storms. They also compared the timing of plume formation to when severe weather actually occurred and when severe weather warnings were issued by the National Weather Service. What they found was significant.

"We found about 400 plume-producing storms across 13 severe weather outbreaks," said Bedka, "and in about 100 of them you had a plume appearing 10 minutes before the first warning, potentially providing additional lead time for saving lives and property."

Originally published on: August 15, 2018

SISTER SATELLITES, BRIEFLY SEPARATED, WORKING TOGETHER AGAIN

CloudSat and CALIPSO: They were designed to complement each other in the 1990s. They launched together on the same rocket in 2006. Then they spent more than a decade orbiting Earth in formation with other satellites in what's known as the A-Train, or afternoon constellation.

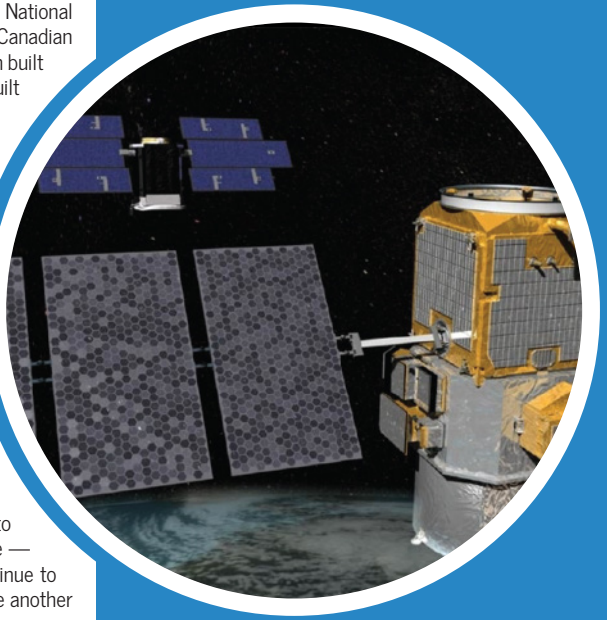
It was a beautiful partnership forged in labs around the world: At NASA's Langley Research Center in Hampton, Virginia, which provided the aerosol-measuring lidar carried by CALIPSO; at the Centre National d'études Spatiales, or CNES, in Toulouse, France, which provided the CALIPSO spacecraft; at the Canadian Space Agency, or CSA, in Montreal, Canada and the Jet Propulsion Lab in Pasadena, California, which built the radar on CloudSat; and at the labs of Ball Aerospace Corporation in Boulder, Colorado, which built the CloudSat spacecraft.

In February 2018, facing a mechanical challenge, CloudSat had to exit the A-Train, moving to a lower orbit and leaving CALIPSO behind. After a well-orchestrated maneuver, CALIPSO rejoined CloudSat. NASA scientists are referring to the new orbit, just a few miles below the A-train, as the C-Train — C being the first letter of each satellite.

"It's not that we're following one another just because we want to," said Chip Trepte, project scientist for CALIPSO, which stands for Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation. "It's because staying together enables the shared science we want to do. It's been the driving part of our missions from the get-go."

At a meeting of the CloudSat and CALIPSO science teams to determine whether CALIPSO should join its sister, there was no debate.

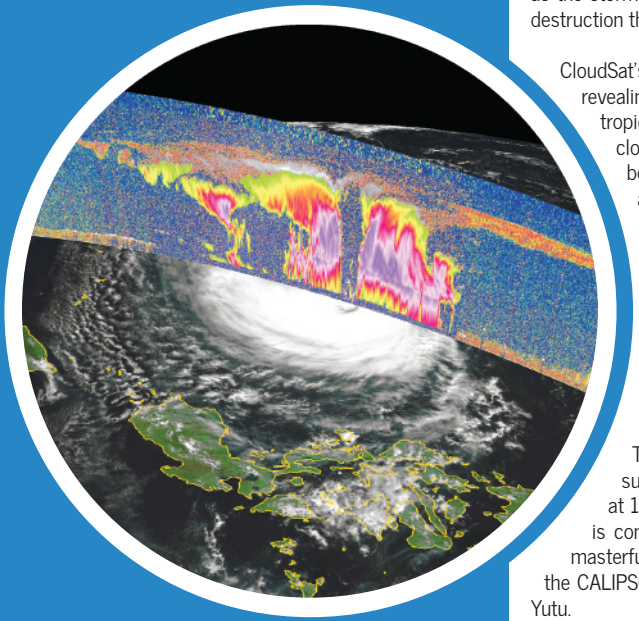
CALIPSO began its exit from the A-Train Sept. 13 and entered its new orbit Sept. 20. The C-Train orbit is approximately 428 miles (688 kilometers) above the Earth's surface. It'll take some time to get the satellites in phase with one another and they'll be a little farther apart than they once were — about 60 seconds. But once they're completely settled in — likely in late October — they'll continue to provide indispensable, complementary views of clouds and aerosols for what scientists hope will be another two years or more.



"...staying together enables the shared science we want to do. It's been the driving part of our missions from the get-go."

Originally published on: September 27, 2018

CALIPSO AND CLOUDSAT OBSERVE TYPHOON YUTU'S VERTICAL STRUCTURE



"CALIPSO and CloudSat, two satellites in the newly formed C-Train, captured a stunning overpass through the eye of Typhoon Yutu on October 28th, 2018"

CALIPSO and CloudSat, two satellites in the newly formed C-Train, captured a stunning overpass through the eye of Typhoon Yutu on October 28th, 2018 at 04:58 UTC as the storm was approaching the Philippines in the West Pacific. Typhoon Yutu contained estimated sustained winds of 120 knots (138 mph) with a minimum pressure of 933 mb. During the overpass, Typhoon Yutu was beginning a period of weakening as the storm was moving into less favorable atmospheric conditions. The Category 5 storm left a trail of destruction through Saipan, Tinian and the Mariana Islands on October 24-25, 2018.

CloudSat's 94 GHz cloud profiling radar (CPR) overpassed directly through the eye of Typhoon Yutu revealing the cirrus-free eye with an outward sloping eyewall, a feature typically found in intense tropical systems. The southern portion of the eyewall appears more disorganized as the thicker cloud tops are starting to disintegrate from the top down. The CPR data reveals the inner details beneath the storm's cloud tops. Intense areas of convection with moderate to heavy rainfall appear in deep red and pink colors, reaching an estimated altitude of 14 km. A cloud-free area can be seen underneath the northern portion of the cirrus canopy as well. Lower values of reflectivity, in green and blue colors, denote smaller ice and water particle sizes typically located at top of the system (in the anvil area). The CPR signal attenuates in heavy rainfall when cloud droplets become larger than 3 mm and effectively dampen the signal's strength. This is evident by the lack of signal typically occurring beneath the melting level when frozen particles transform into liquid.

The CALIPSO lidar, also known as Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), complements CloudSat radar measurements by observing ice cloud particles at the top of Typhoon Yutu. CALIOP data is visualized to the right as a bluish cross-section, with CPR data superimposed on it. CALIOP measured the top of the typhoon and its accompanying cirrus shield at 15 to 18 km above the ocean surface. The cirrus shield, spanning some 1,200 km horizontally, is comprised of ice crystals formed within the outflow of the typhoon at high altitudes. CALIOP masterfully observes these tenuous ice crystals, shown in grey, red, and yellow in the image. Together, the CALIPSO and CloudSat observations provide a complete picture of the vertical structure of Typhoon Yutu.

Originally published on: November 1, 2018

GROWING PRACTICAL USES OF NASA ENVIRONMENTAL DATA FOR 20 YEARS

Three students and a mentor planted a seed at NASA's Langley Research Center in Hampton, Virginia. The year was 1998. The seed was a paper called "The Practical Applications of Remote Sensing."

By 1999, a new NASA student internship program had taken root. Its name: DEVELOP. Its goal: to apply NASA Earth science observations to community concerns around the world.

DEVELOP is celebrating its 20th anniversary this year — and its branches have grown. They now spread nationwide and include more than 350 participants and 60 partners yearly at 12 locations around the country. Participants and partners together grow their awareness and skills to use NASA Earth observation data to address environmental issues.

In September, a small group at Langley marked DEVELOP's 20th anniversary with a ceremony that included a tree planting and the unveiling of a plaque that read: In recognition of the 20th Anniversary of the DEVELOP National Program — A Sturdy Tree Grows — "With a Little Help From My Friends."

"The program continually reminds me of the great people we meet in the communities we serve, that there is widespread interest in the type of science NASA does and a lot of interested partners at the local, state and federal levels," said Mike Ruiz, manager of the DEVELOP National Program. "It's a continual reminder of the passion people have to better understand their environment."

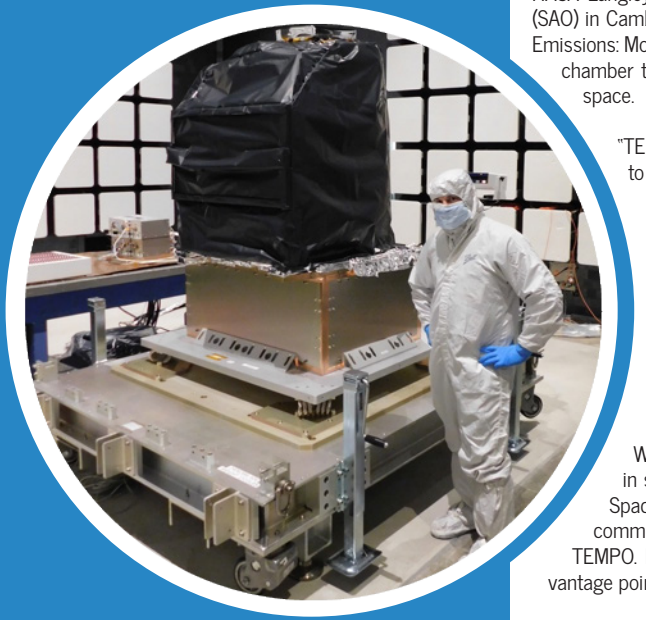
DEVELOP projects have focused on everything from West Nile risk in Monterey County, California, to the allocation of agricultural water resources in Coquimbo region of Chile. Other application areas for DEVELOP projects include air quality, disasters, urban development, energy, and transportation and infrastructure. Projects run for 10 weeks.

DEVELOP had a dynamic 20th anniversary year, engaging 308 participants and 121 partner organizations through 65 projects that took place at 13 nodes. These projects, and the participants that conducted them, impacted 46 U.S. states and 22 countries. In January 2018, DEVELOP expanded its network through the establishment of a new node in Boston, Massachusetts, hosted by Boston University with lead collaborators from the USGS Woods Hole Coastal and Marine Science Center. The program presented project results and participated in 35 science and policy conferences and meetings, co-chaired sessions at two conferences (American Geophysical Union (AGU) Fall Meeting and American Association of Geographers Annual Meeting), and supported five NASA review panels. The program also had five peer-reviewed journal publications and continued its video series highlighting the use of Earth observations in decision making, with 34,249 YouTube views from 17 countries in 2018.

"The program continually reminds me of the great people we meet in the communities we serve, that there is widespread interest in the type of science NASA does and a lot of interested partners at the local, state and federal levels"

Originally published on: November 5, 2018

NASA'S TEMPO AIR POLLUTION SENSOR COMPLETED



"TEMPO exploits 30 years of our development of ultraviolet and visible atmospheric spectroscopy to make air quality measurements at revolutionary spectral and spatial scales"

An Earth science instrument to measure air pollution over North America has successfully completed development by Ball Aerospace and Technologies Corp. in Boulder, Colorado, and has been formally accepted by NASA Langley Research Center.

NASA Langley and Principal Investigator Kelly Chance, from the Smithsonian Astrophysical Observatory (SAO) in Cambridge, Massachusetts, partnered with Ball to design, manufacture and test the Tropospheric Emissions: Monitoring of Pollution, or TEMPO, Earth science instrument. TEMPO underwent thermal vacuum chamber testing at Ball, which verifies the instrument can survive the extreme heat and cold of outer space.

"TEMPO exploits 30 years of our development of ultraviolet and visible atmospheric spectroscopy to make air quality measurements at revolutionary spectral and spatial scales," said Chance.

TEMPO will be the first space-based instrument to monitor major air pollutants across the North American continent hourly during daytime. In doing so, it will revolutionize air quality forecasts and emission control strategies, and enable effective early public warning of pollution events.

"With completion of the instrument and full spaceflight qualification by Ball, we are extremely excited about the acceptance of TEMPO, which will lay the framework for NASA and SAO's critical air quality measurements," said TEMPO Project Manager Stephen Hall at NASA's Langley Research Center in Hampton, Virginia.

While NASA has taken ownership of the TEMPO flight hardware, the instrument will remain in storage at Ball until a host spacecraft is selected. NASA will partner with the U.S. Air Force's Space and Missile Systems Center in El Segundo, California to issue a request for proposals from commercial companies to provide satellite integration, launch services and ground operations for TEMPO. Flying on this commercial spacecraft, TEMPO will make observations from a geostationary vantage point, about 22,000 miles above Earth's equator.

TEMPO is the first instrument to be awarded by NASA's Earth System Science Pathfinder Program in the Earth Venture Instrument (EV-I) Class Series.

Learn more about the science behind the TEMPO instrument in a video produced by SAO at tempo.si.edu.

Originally published on: December 7, 2018

YES, THE SUN IS LESS ACTIVE. NO, YOU'RE NOT LIKELY TO NOTICE

Chill out.

That's the current message from the Sun to Earth's upper atmosphere. To be more precise, as the Sun settles into a cyclical, natural lull in activity, the upper atmosphere, or thermosphere — far above our own climate system — is responding in kind by cooling and contracting.

Could that have implications for folks down here on the surface? Absolutely not. Unless, that is, you're someone with a vested interest in tracking an orbiting satellite or space debris.

Beginning approximately 60 miles above Earth's surface and extending out to about 375 miles, the thermosphere is where the Sun and the atmosphere first interact. When solar activity is low, like it is now, and the thermosphere cools and contracts, satellites in low-Earth orbit feel the effects.

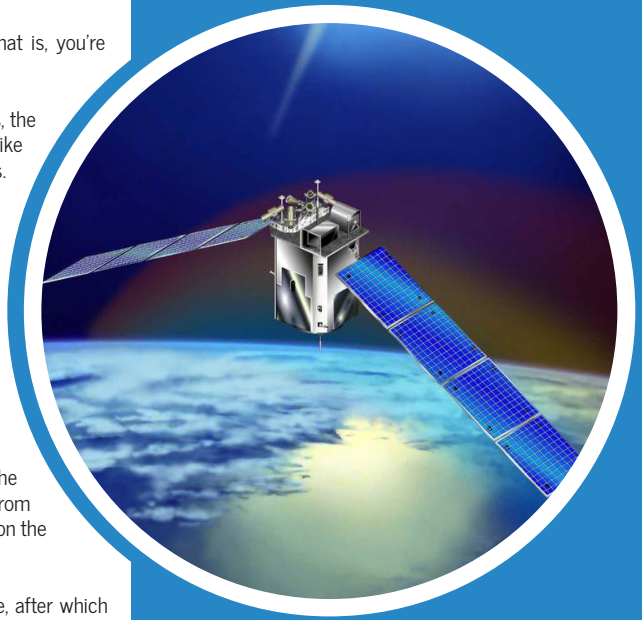
"They encounter less drag and their orbits will not decay as much due to that. It's good for satellites," said Marty Mlynczak, a senior atmospheric scientist at NASA's Langley Research Center in Hampton, Virginia.

To be totally clear, this cooling is natural and specific to the thermosphere. The cooling thermosphere does not affect the troposphere, the layer of the atmosphere closest to Earth's surface where people live. The temperatures we experience on the ground do not get colder due to this solar cycle. NASA and other climate researchers continue to see a warming trend in the troposphere. These two effects are ongoing but unrelated.

Mlynczak and some of his colleagues recently published a study that compared findings from the current solar minimum with findings from the last minimum in 2009. Their observations came from the Sounding of the Atmosphere using Broadband Emission Radiometry, or SABER, instrument on the Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics, or TIMED, satellite.

On average, solar cycles last around 11 years. We're likely on the tail end of the current cycle, after which solar activity will begin picking up and the thermosphere will warm and expand. The TCI will be tracking that closely.

"The current cold conditions in the thermosphere are not a permanent thing," said Mlynczak. "It's cyclical."



"To be totally clear, this cooling is natural and specific to the thermosphere. The cooling thermosphere does not affect the troposphere, the layer of the atmosphere closest to Earth's surface where people live."

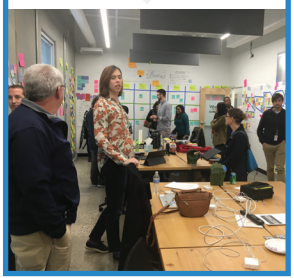
Originally published on: December 10, 2018

Jim Crawford presents "Developing Future Air Quality Observing Strategies: Contributions from NASA's Airborne Field Studies," at Hampton University

Earth Day at Union Station

TEMPO Instrument TVAC test

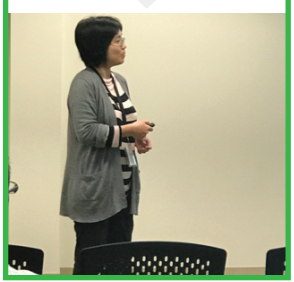
Red Hat Residency Design Project



Jessica Taylor received the 2018 Women of Color in STEM award for Education Leadership - Corporate Promotion of Education

STEAM Day at Dare Elementary

Xiaomei Lu Presents an SSAI Technical Brief titled "Development of Innovative Uses of CALIPSO Data."



Director Dave Young delivered a presentation to Administrator Jim Bridenstine during his visit to NASA Langley Research Center

DEVELOP held a tree planting ceremony to celebrate 20 Years of DEVELOP

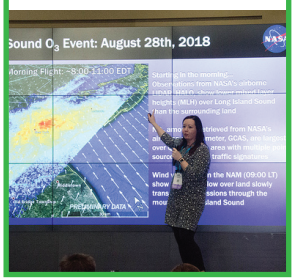
SD/SSAI Summer Picnic

ATom-4 Deployment

Ali Omar delivers a presentation at the Air and Waste Management Association Conference

Naval Air Station Oceana Show

Laura Judd presents at AGU 2018



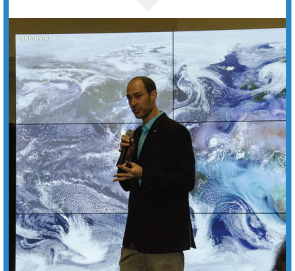
Rich Moore presents at AGU 2018

SSAI's Annual Tailgate Party

NASA Disasters Congressional Hazard Caucus

Abbie Corbett, Rob Ryan and Travis Toth win the grand prize for the SD Door Decorating Contest

Patrick Taylor presents at AGU 2018



Paul Stackhouse presents at AGU 2018

BATAL Workshop in
Gadanki, India

CALIPSO/CLOUDSAT
Science Team Meeting

Jack Kaye
Visits NASA Langley

COSPAR 2018

CAMP2Ex Planning
Meeting

NAAMES
Workshop

MESCAL Meeting

SD Participates in the
Langley Summer Games

NDMAX/ECLIF

GSFC Senior Leadership visits Langley

ORACLES Final Deployment

Diamantes Program Visits NASA Langley

SSAI's Adopt-a-Spot

Qing Trepte and Nitchie Smith serve cool treats during SSAI's summer Ice Cream Social

Marilé Colón Robles, Tina Rogerson, Tina Harte receive the Chairman's Innovation Award at SSAI's Annual Winter Gala

Proposal Development Office Retreat

FY18 METRICS

NASA's most prestigious honor awards are approved by the Administrator and presented to a number of carefully selected individuals and groups of individuals, both Government and non-Government, who have distinguished themselves by making outstanding contributions to the Agency's mission.

Individual Awards

Joseph Zawodny	Distinguished Service Medal
Margaret Pippin	Equal Employment Opportunity Medal
Richard Cageao	Exceptional Service Medal
Michael Ruiz	Exceptional Service Medal
Susan Kooi	Exceptional Public Service Medal
Carolus Verhappen	Exceptional Public Service Medal
Christopher Bedka	Exceptional Achievement Medal
Amy Jo Scarino	Early Career Public Achievement Medal
Carol Castle	Exceptional Administrative Achievement Award
Marguerite Madden	Silver Achievement Medal

Group Achievement Awards

Carbon Dioxide Double-Pulse Two-Micron IPDA Lidar
Centennial Anniversary Teams
NASA Disasters Response Coordination Team

Silver Achievement Medals

DEVELOP National Program Team
GeoCARB Acquisition Support Team
STARSS III SEB and Contract Phase In Team

NASA Langley Science Directorate Funds

Science Directorate (SD) FY18 funding came from awarded proposal solicitations and directed work, and Agency offices that reside at Langley.

SMD Funding Guideline at Langley (total dollar amount)

$239,247,084

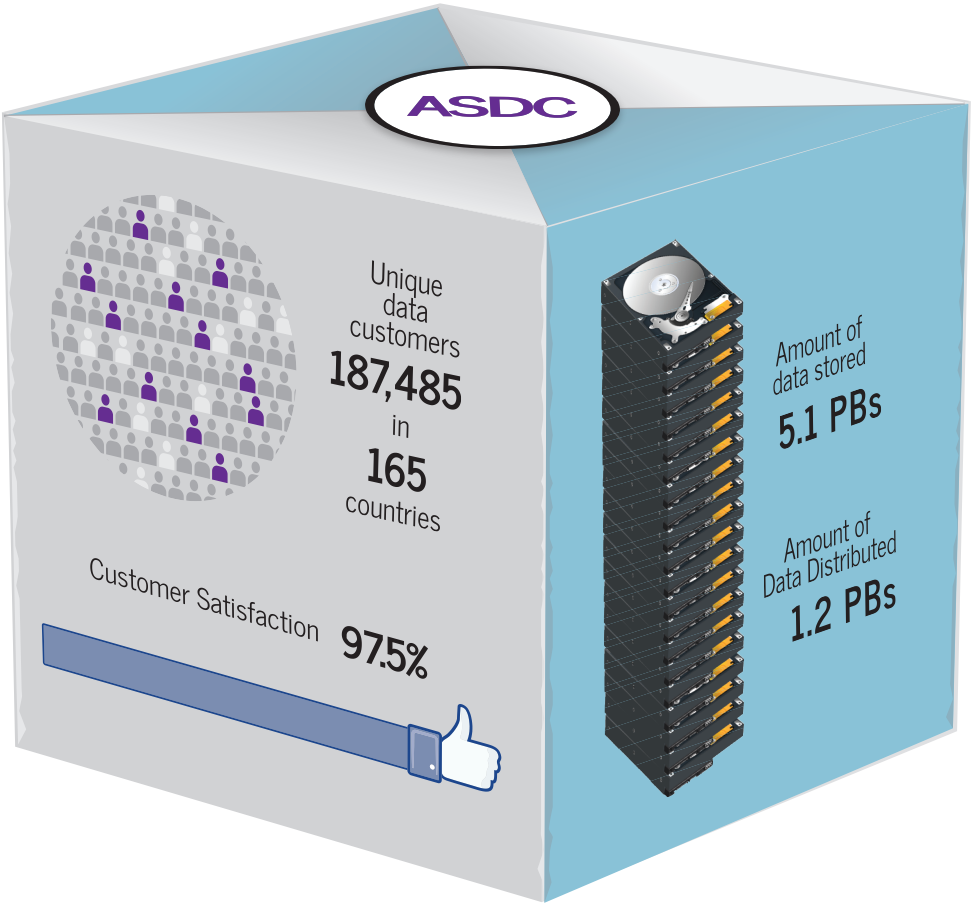
Agency Functions Resident at Langley (subset of total dollar amount)

$80,741,089

Science Directorate and "other" funding (subset of total dollar amount)

$158,505,995

Metrics from NASA Langley's Atmospheric Science Data Center (ASDC) provide a measure of our success in serving a broad and growing customer base.



A round-up of FY18 metrics from several NASA Langley teams and projects.

Science Education Team

Educators & adults reached: ~**3,000**
Provided resources: ~**12,000**
Students reached: ~**6,500**
Public events held: ~**70**

DEVELOP

Nationwide participants: **330**
Total projects: **67**

CLARREO

Estimated economic value of higher accuracy climate observations:
$10 to **$20 Trillion**

*AGU Research Article 10.1002/2017EF000627

CALIPSO

Orbits
FY: 5,315 Total: 66,093
Laser shots
FY: 609,091,584 Total: 7.25 billion
Light Emitted
FY: 12.18 Total: 144.70 seconds

SAGE

Total Occultation Acquired: **12,421**
Sunrises acquired: **5,956**
Sunsets acquired: **5,596**
Moonrises acquired: **283**
Moonsets acquired: **586**

SABER

Years on orbit: **17.5**
Journal articles: **1880**
Thesis: **33**

CERES

Produced **107 TB** of data in order to generate **14.1TB** of publicly orderable climate data products.

Publication, citation and review metrics are an indication that our organization is valued as experts in scientific research.

Published Work Citations FY18

72,259

Peer-reviewed publications FY18

189

Requested Reviews in FY18

27

National Aeronautics and Space Administration

Langley Research Center
100 NASA Road
Hampton,VA 23681
www.nasa.gov/centers/langley

www.nasa.gov

NP-2019-04-018-LaRC