LASP SPACE
Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**
Issue 11 • June 2018

Features: **GOLD launches • CubeSats are popular • Grand Challenge win • Extreme life in volcanic lake**

Letter from the director

Dan Baker

Celebrating 70 years of solar and space physics

The past seven decades have taken the University of Colorado from the first exploratory rocket measurements of the Earth's upper atmosphere to amazing investigations of all the planets in our solar system—and beyond. From humble beginnings as the Upper Air Laboratory through the transition to the Laboratory for Atmospheric and Space Physics (LASP) in 1960, the lab has performed state-of-the-art observations supported by cutting-edge theory and superb data analysis. In the modern era, LASP has devised a remarkable array of missions and instruments to expand the frontiers of knowledge. On a daily basis we obtain a deeper understanding of our nearest star, the Sun, and we extend our gaze not only to our home in space but also to planets around other suns far out in our galaxy.

Who knows where our exploration will lead us? We do know that LASP will continue to push the boundaries of human understanding and apply our present wisdom to the challenges that lie ahead. As we look back and celebrate LASP's 70th anniversary, we also look forward to the next decades that are before us.

IN FOCUS

GOLD launches for unprecedented study of Earth's upper atmosphere

Liftoff of the Ariane 5 carrying the GOLD instrument. *(Courtesy Arianespace)*

The LASP-built Global-scale Observations of the Limb and Disk (GOLD) instrument launched on January 25 from Kourou, French Guiana, marking another milestone in its pioneering mission. In a spectacular nighttime launch on an Ariane 5, GOLD was inserted into a transfer orbit on its way to geostationary orbit in July.

GOLD is hosted on SES-14, one of the first geostationary satellites to use electric propulsion for orbital transfer. Use of electric rather than chemical propulsion reduces the mass of SES-14 significantly.

An ultraviolet spectrograph, GOLD will provide the first images of temperatures in the lower regions of the neutral thermosphere across the daytime disk of the Earth—measurements researchers have dreamed about for decades. GOLD will also image the ratio of atomic oxygen to molecular nitrogen in the same region. On the nightside of Earth, GOLD will image peak densities of the low-latitude ionosphere.

Thirty-minute scans of the Western Hemisphere will allow research to advance from long-term climate studies to the day-to-day effects of atmospheric tides and space weather in the Earth-space interface. These unique observations will improve prediction of space weather impacts on Earth, which can disrupt radio and GPS communications, affecting everything from airline travel, to farming, TV programming, and cell phone connections.

GOLD is a multi-disciplinary mission for LASP, involving engineering, science, operations and communications. It is the first NASA mission to fly as a hosted

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Mission & technical stats

- LASP operates 4 satellites.
- LASP operates 145 instruments on 17 spacecraft.
- LASP is currently developing 7 spacecraft and 16 instruments for 13 missions.

Staff stats

(May 1, 2018)

Scientific researchers	71
Tenure-track faculty	22
Visiting faculty	4
Professionals	316
Graduate students	50
Undergraduate students	109
Others (retirees and temps)	20
Total	**592**
Affiliates	232
Open positions	19

For employment information, visit http://lasp.colorado.edu/home/about/jobs.

Achievement awards

Research assistant and CU Boulder undergraduate student Parker Hinton received an American Geophysical Union (AGU) award to present his research on Jupiter's Io plasma torus on the NASA Hyperwall at the AGU 2017 Fall Meeting in New Orleans. Hinton was also one of two recipients of LASP's 2017 Charles A. Barth Scholarship in Space Research.

payload on a commercial, geostationary satellite whose primary mission is to provide communications, not science. Hosting payloads on commercial satellites is a groundbreaking approach with the potential to provide science missions more frequent and cost-effective access to orbit.

For more information on LASP GOLD, see http://lasp.colorado.edu/home/missions-projects/quick-facts-gold/.

By Richard Eastes, GOLD principal investigator and LASP research scientist.

CubeSats are popular—CUTE too

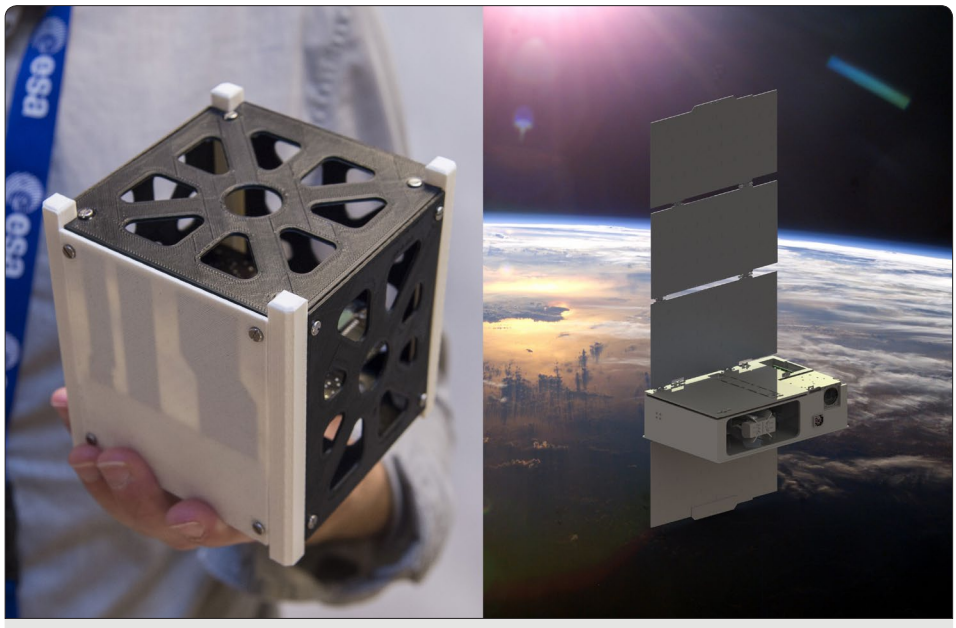
CubeSats—small satellites that allow for reduced cost and increased accessibility to space—are becoming increasingly popular. The small spacecraft are made up of 10 cm^3 units (U), and the largest NASA currently supports is a 6U (10 cm x 20 cm x 30 cm) CubeSat. LASP is keeping up with this technology trend with recent CubeSat projects including CSSWE, CSIM, CTIM, INSPIRE, and MinXSS.

The newest CubeSat under development at LASP, in conjunction with the CU Boulder Department of Astrophysical and Planetary Sciences, is the 6U Colorado Ultraviolet Transit Experiment (CUTE). The first NASA grant-funded, UV/optical, astrophysics CubeSat, CUTE will study the shape and composition of evaporating atmospheres of "hot Jupiters," giant gas planets orbiting extremely close to their host stars. CUTE's dedicated mission architecture enables larger individual science investigations than are possible with a shared resource facility like the Hubble Space Telescope.

With a scheduled 2020 launch date, CUTE science observations will complement observing programs carried out by the James Webb Space Telescope.

For more on CUTE, see http://lasp.colorado.edu/home/cute/.

By Arika Egan, CU Astrophysical and Planetary Sciences graduate student and CUTE scientist.



Left: A single 1U CubeSat can fit into the palm of your hand. Right: This artistic rendering of LASP's 6U CUTE CubeSat shows four solar panels, an optical system, and star trackers. *(Left: Courtesy ESA–G. Porter, CC BY-SA 3.0 IGO; Right: Courtesy Stefan Ulrich, LASP/Blue Canyon Technologies)*

Mission status

Instrument Development (Pre-Phase A)
- MatISSE LAMA

Phase A/B (funded concept study)
- CLARREO Pathfinder
- TSIS-2
- CIRBE CubeSat
- CUTE CubeSat
- FOXSI/HFSS
- Compact TIM CubeSat

Phase C (design and fabrication)
- Europa Clipper/SUDA

Phase D (assembly and test)
- Compact SIM CubeSat
- Emirates Mars Mission (EMM)
- GOES-T/EXIS, GOES-U/EXIS
- Parker Solar Probe (PSP)

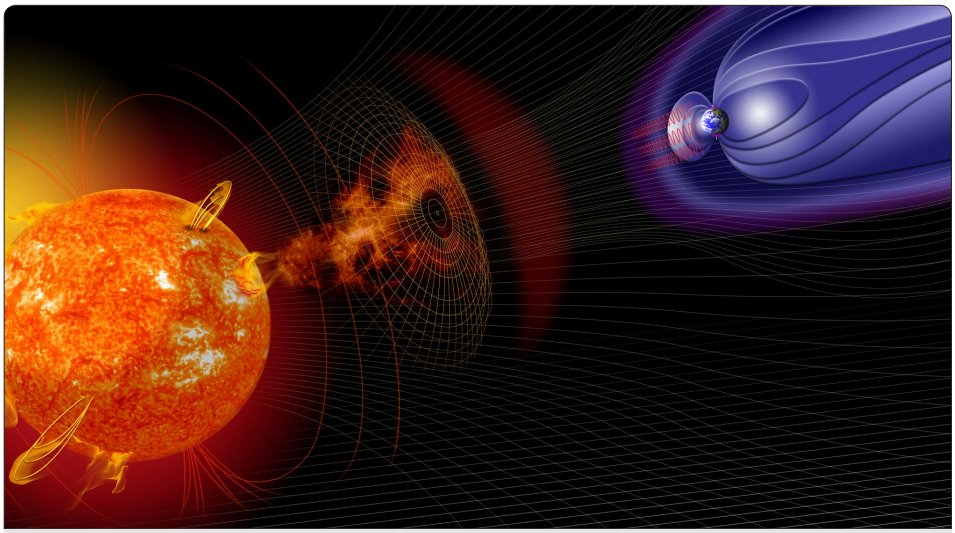
Launch/Early Orbit [launch date]
- GOLD [Jan. 2018]
- GOES-17/EXIS [Mar. 2018]
- MinXSS-2 CubeSat [Oct. 2018]

Prime Mission [end date]
- TSIS-1 [2023]
- GOES-16/EXIS [2026]

Extended Mission [end date]
- MAVEN [2018]
- New Horizons/SDC [2018]
- QuikSCAT [2018]
- STPSat-3/TCTE [2018]
- Van Allen Probes REPT/FIELDS [2018]
- Kepler/K2 [2018]
- SORCE [2019]
- AIM [2020]
- SDO/EVE [2020]
- THEMIS and ARTEMIS [2020]
- TIMED/SEE [2020]
- MMS, four spacecraft [2020]

For more information on current missions, as well as full instrument and mission names, visit http://lasp.colorado.edu.

Grand Challenge win establishes space weather center at LASP



SWx-TREC will advance forecasting research and mission technologies to enhance understanding and prediction of space weather phenomena between the Sun and the Earth. *(Courtesy NASA)*

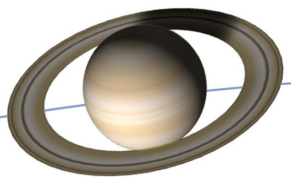
Last November, CU Boulder announced the winners of the "Our Space. Our Future" Grand Challenge competition in response to President Obama's call to pursue the grand challenges of the 21st century. One of three proposals selected was the Space Weather Technology, Research, and Education Center (SWx-TREC), a collaboration between LASP and the CU departments of Aerospace Engineering Sciences, Astrophysical and Planetary Sciences, Atmospheric and Oceanic Sciences, and the Cooperative Institute for Research in Environmental Sciences.

From LASP's Space Sciences Building, SWx-TREC will coordinate space weather research, mission development, and education—tying together activities that were previously isolated in the various departments. It will also be a focal point for interactions with NOAA's Space Weather Prediction Center (SWPC) in Boulder, the nation's civilian space weather forecasting authority.

Tom Berger, former SWPC director, is the founding director of SWx-TREC, ensuring close ties between space weather research and operations in the Boulder community and beyond. LASP Director Dan Baker is a lead co-investigator and Chris Pankratz, LASP data systems and project manager, will lead the Models, Applications, and Data Technology office.

For more information on SWx-TREC, visit https://www.colorado.edu/spaceweather/.

By Tom Berger, SWx-TREC director and LASP visiting research scientist.



FIELD NOTES

Extreme life in volcanic lake—and possibly on Mars?

Astrobiology fieldwork in active Costa Rican volcanoes helps us understand similar past environments on Mars, as identified by rovers and orbiters. The Poás Volcano's Laguna Caliente is one of Earth's most dynamic, extreme environments (acidity can reach 100 million times that of tap water and temperatures can reach almost boiling). Many processes and materials found there are good analogs for ancient hydrothermal systems on Mars.

LASP PhD candidate Sarah Black using a Mars analog VNIR spectrometer to determine the volcano's composition. *(Courtesy Brian Hynek, Ramy El-Maarry)*

LASP scientists Brian Hynek and Ramy El-Maarry, along with graduate student Sarah Black, have been examining this environment since 2013. Their studies yield insights into microbes that could have inhabited ancient Martian hot springs and represent the first time Laguna Caliente waters and sediments have ever been sampled for microbiology. They recovered DNA that revealed a single acid-tolerant bacterium (acidiphilium), which is likely a novel (not-yet-described) organism because related species cannot tolerate such acidity. The ecosystem exhibits perhaps the lowest diversity of any described to date on Earth. Given similar conditions on ancient Mars, this analog work provides keys to the organisms and lack of diversity that might have existed there.

For more information on the Center for Astrobiology, see http://lasp.colorado.edu/home/life/.

By Brian Hynek, research scientist at LASP and an associate professor of geological sciences at CU Boulder.

INNER SPACE

News

GOES-17 joins GOES-16 in weather-monitoring mission

On March 1, the GOES-17 weather satellite launched on a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station, sending the LASP-built Extreme ultraviolet and X-ray Irradiance Sensors (EXIS) on its way to geostationary orbit around the Earth.

GOES-17 is the second of four satellites making up the fifth generation of the Geostationary Operational Environmental Satellite (GOES) program that monitors weather conditions across the western hemisphere. The EXIS instrument suite is the second of four identical packages that monitor potentially damaging space weather. EXIS measures energy output from the Sun that can affect satellite operations, telecommunications, GPS navigation, and power grids on Earth. The EXIS suites consist of an Extreme UltraViolet Sensor (EUVS), an X-Ray Sensor (XRS), and a combined EUVS/XRS electronics box (EXEB) to control subsystems and to provide a command and data-handling interface with the spacecraft. EXIS provides one of the most important observations for early warning of space weather events.

For more information, visit http://lasp.colorado.edu/home/missions-projects/quick-facts-goes-r/.

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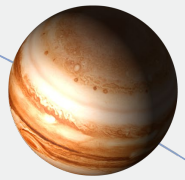
To view LASPSpace archives, visit http://lasp.colorado.edu/home/about/publications/newsletters/.



Education and Outreach

Final year of IMPACT-supported Junior Aerospace Engineering program

LASP's Office of Communications and Outreach (OCO) is in the final year of a five-year Junior Aerospace Engineering program, in which students from Casa de la Esperanza in Longmont have learned physics and engineering concepts related to rocketry and robotics.

The program, with support from the LASP-affiliated IMPACT center, is intended to attract and retain underrepresented students in science, technology, engineering, and mathematics (STEM) disciplines. Many students have attended all three camps—offered every other summer—as they've progressed from elementary through high school.

After two years of rocket-focused activities, the program concludes this summer with a Robotic Lunar Rover program. Using NASA-approved curricula, OCO staff, alongside IMPACT scientists and CU Boulder students, have provided greater in-depth content for each year of the program.

Evaluations of the program have shown that students have increased their understanding of critical science and engineering concepts, and have demonstrated an increased interest in related careers.

Administrative update

Funding contribution to CU remains strong

LASP continues to contribute significantly to CU Boulder's sponsored research profile, accounting for nearly 44% of total research funding in the last year. During that time, LASP proposed 42 sponsored research agreements (SRAs), valued at $167,834,716 and was awarded 18, valued at $30,451,958. The lab also proposed 160 grants, valued at $53,825,587 and was awarded 49, valued at $15,916,196. During the last year, LASP generated revenue of $132,920,095 on SRAs and $11,588,983 on grants and the current backlog for both exceeds $152.5M.

Key hires

Tom Berger joined LASP as the director of the new Space Weather Technology, Research and Education Center (SWx-TREC), currently housed in LASP's Space Sciences building. SWx-TREC is a national cross-disciplinary center combining research, technological innovation, and education to enable federal agencies, academia, commercial partners, and industry to collaborate on the nation's evolving space weather forecasting, mitigation, and response efforts.

Notable departure

Bill Possel, director of Mission Operations & Data Systems, departed LASP on March 16 after eleven years leading the technical activities of the division. He led LASP spacecraft and space instrument operations, operational ground software, and data processing and analysis systems. Bill leaves LASP to return to his roots in the national security space industry.