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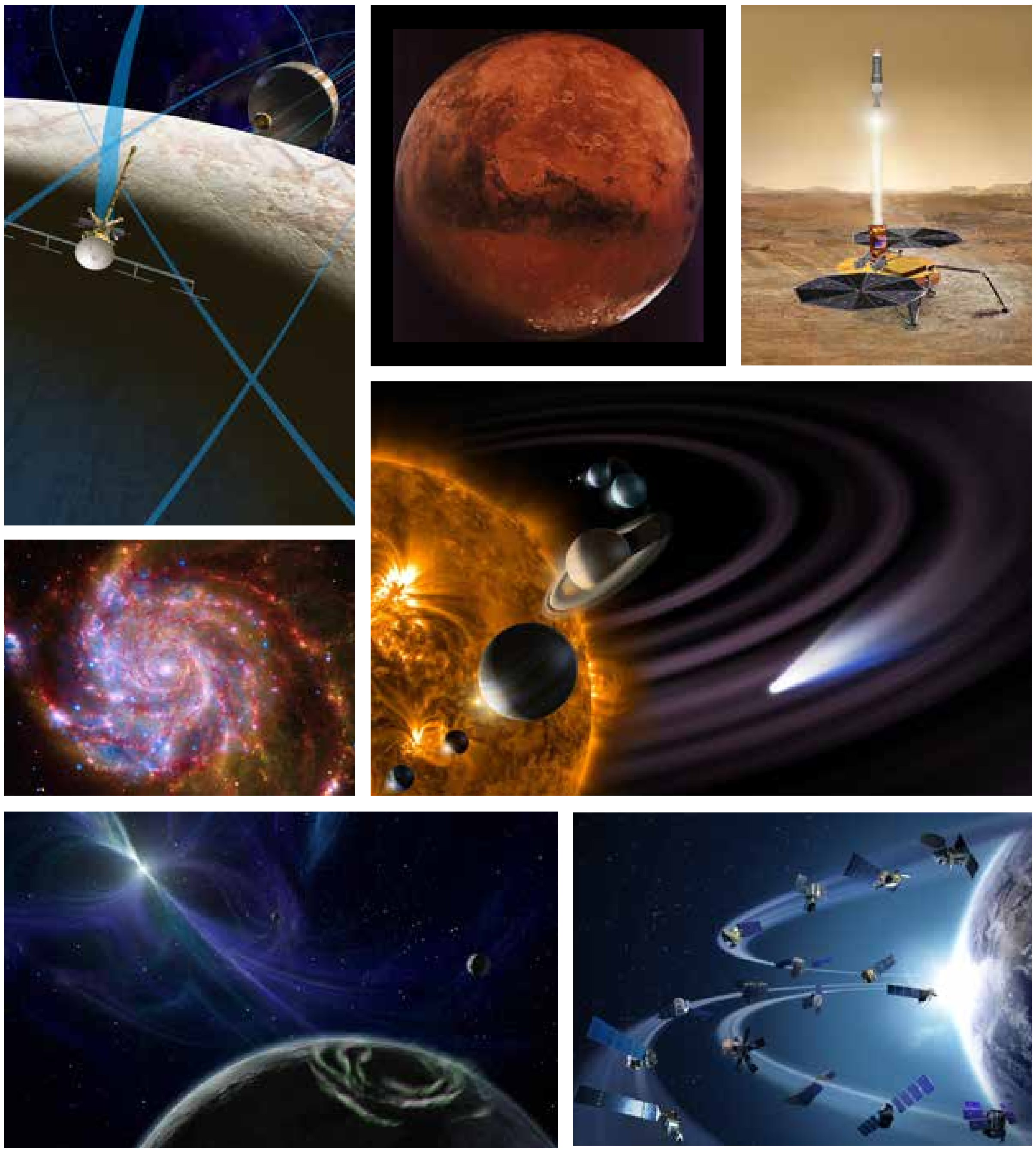


Clockwise: 1) Europa Clipper; 2) Mars; 3) Mars Sample Return lander; 4) solar system; 5) Earth satellites; 6) the pulsar planets PSR B1257+12 b, c, and d; 7) spiral galaxy Messier 101.

What will JPL be like in 2025? What kind of missions will it be building and flying? How different will the lab be from the JPL of today?

Those were the questions on the minds of Executive Council members in early May when they held their annual planning retreat. Over three days they laid out the broad strokes of strategies to make each of the lab's major program areas robust a decade or more from now.

"JPL is currently in good shape, but to remain that way we have to focus on where we are going across the next decade," JPL Director Charles Elachi said following the off-site meeting.

Among the strategies planned for JPL's major units, in coming years the Solar System Exploration Directorate hopes to create missions across a broad spectrum of scales—from flagships to miniature spacecraft. One major focus is to explore the ocean worlds in the outer solar system. The first step for this goal is to continue the development of what is hoped will be the next outer planet mission, Europa Clipper.

Thanks to the power of NASA's new Space Launch System, missions to the outer planets may become more frequent. JPL would also like to execute the first interplanetary mission using a pair of miniature cubesat spacecraft. The Asteroid Redirect Mission in which JPL has a key role may serve as a model for future closer collaborations with other NASA centers.

The Mars Exploration Directorate will be busy carrying out current and future missions to advance the search for life at the Red Planet and prepare for human exploration. After building and flying the next rover, Mars 2020, JPL would like to undertake the holy grail of Mars exploration—a long-desired sample return mission, based on a lander and orbiter that could fly in the 2020s.

Cutting-edge areas of space-based astronomy are on the list of goals for the Astronomy, Physics and Space Technology Directorate. These fall in areas such as the hunt for Earth-like planets orbiting other stars; the study of dark energy, the invisible energy that could make up more than two-thirds of the universe; and the use of infrared telescopes to better understand near-Earth objects. Those efforts are expected to benefit from technologies that JPL is developing both for NASA and for the Department of Defense.

Providing decision-makers the information they need to benefit and protect society is a central goal for the Earth Science and Technology Directorate. JPL will pursue missions and studies in the four broad areas of sea-level rise, global water cycle, carbon cycle, and natural hazards such as earthquakes and volcanoes. The directorate will work on missions identified as high priorities in the National Academy of Sciences decadal surveys, compete in NASA's Earth Venture Program and grow its slate of airborne missions.

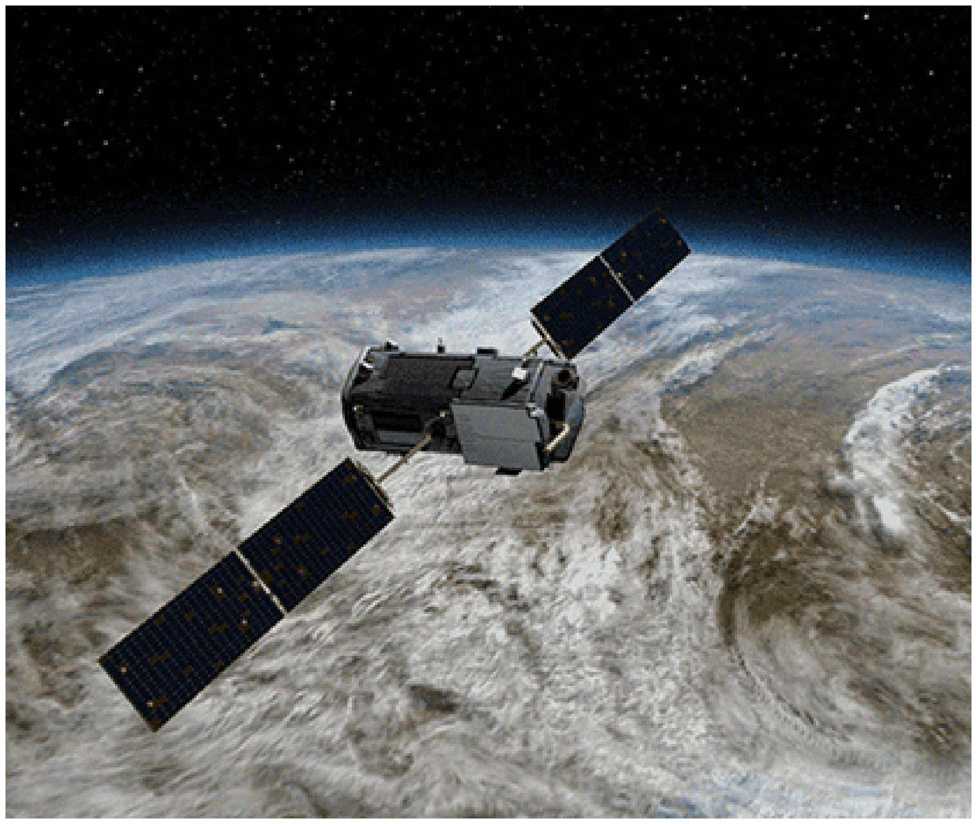
In coming years, the Interplanetary Network Directorate will develop optical communications for the Deep Space Network as the essential link to missions across the solar system. Another ambition is to begin work on creating a solar system version of the World Wide Web that connects space assets with each other and with people.

Given that JPL is a national asset that undertakes projects based on the needs of the country, the lab will continue to conduct non-NASA work with government agencies and other partners. These assignments are synergistic: supporting the nation while at the same time helping JPL to develop new technologies essential for the future exploration of the solar system and beyond.

Elachi noted that many new technologies will change the way JPL does business a decade or more from now. For example, technologists are working on systems that will allow mission ops teams to control spacecraft via virtual-reality interfaces instead of through keyboarded commands. Miniature satellites such as cubesats, he added, are an increasingly attractive way to do science at low cost.

Orbiting Carbon Observatory 2 set to make its mark

By Mark Whalen



OCO 2 vacuum chamber

It's been a long five years since a launch vehicle failure ended JPL's Orbiting Carbon Observatory mission before it had even started. The experimental mission was set to measure carbon dioxide in Earth's atmosphere to gain a better understanding of Earth's carbon cycle and climate change.

Undaunted, key mission personnel set about proposing a follow-on mission to continue the chase of observing this most important of human-produced greenhouse gases from space. The trials and tribulations of developing a new mission, getting it approved, funded and built, are now over.

> In developing the project, the JPL team has benefited greatly from its collaborations with Japan's Greenhouse Gases Observing Satellite (GOSAT) mission, which has provided global coverage over a much broader spectral region than will OCO 2.

Sporting a new launch vehicle and a rebuilt instrument, Orbiting Carbon Observatory 2 is scheduled to launch July 1 from Vandenberg Air Force Base.

"Fundamentally, OCO 2 is a science experiment, to teach us how to measure carbon dioxide in Earth's atmosphere," said science team leader David Crisp. "It's also designed to help us solve a critical problem in the carbon dioxide budget of the planet. This is the toughest trace gas measurement we have ever attempted from space."

Humans are now adding almost 40 billion tons of carbon dioxide to the atmosphere every year—by burning fossil fuels, clearing forests and other activities, Crisp said, adding that's enough carbon dioxide to increase the atmospheric concentration by 1 percent per year.

"But it's only going up a half percent per year," Crisp said. "Where is the rest of the carbon dioxide going? We're missing half of it. It's being absorbed by the ocean; we don't know why. It's being absorbed somewhere on land; not only do we not know why, we don't know where. This is the climate question we're trying to answer with OCO 2."

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One significant development, noted deputy project scientist Annmarie Eldering, was the ability to further mature the fundamental algorithm for producing OCO data products.

"It was an incredible advantage and benefit to the team because we were able to significantly speed up the algorithm," she said. "We learned a lot from putting the GOSAT data through our algorithm and developed a deeper understanding and confidence."

GOSAT makes about 10,000 measurements a day; of those, only between 300 and 1,000 typically yield high-quality carbon dioxide estimates. Clouds are the main problem, noted Crisp.

"GOSAT has returned excellent data. But it's not giving us the coverage or the resolution we need to solve the major problems we originally set out to solve with OCO and hope to with OCO 2," he said. "We need more data."

OCO 2 will take not just a little more data; it will take a lot more data, Crisp noted. "It takes GOSAT four seconds to make one measurement," he said. "OCO 2 collects 24 measurements every second. So we will collect 96 times as much data as GOSAT."

"The price they pay for that broader spectral coverage is they have about 100 times fewer samples on the ground each day than we will get," added Eldering. "GOSAT has a 10-kilometer-diameter footprint, whereas we measure eight footprints across 10 kilometers."

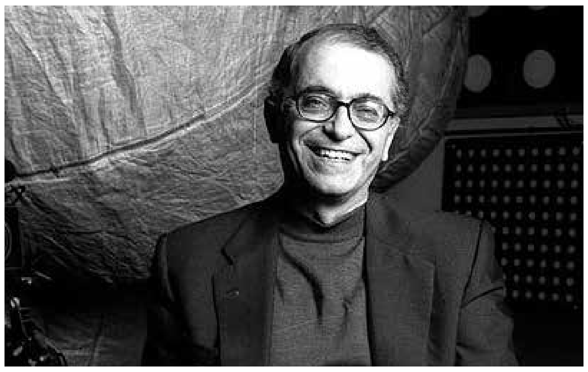
OCO 2 also seeks to improve on GOSAT's sampling of high latitudes and tropical rainforests. "We have almost no data over either of those places, because of clouds or very dark surfaces," said Crisp.

"Unlike other trace gases, you can make a measurement that's accurate to within a few percent and it's very good. For OCO, and then for GOSAT, the measurement needs to be accurate to within ¼ of 1 percent to be of value."

"We always appreciated that this was a very difficult measurement to make," he added. "But we didn't realize how difficult it was to get measurements as precise as we needed to make a real contribution here."

As a global observation mission, OCO 2's science and implementation teams will be augmented by a new science team to be selected in September. About 30 percent of the formal OCO 2 team includes foreign researchers from across Europe as well as Japan. Crisp said principal members of the GOSAT team will be on the OCO 2 team as well.

The way forward



On the heels of an Executive Council retreat dedicated to charting JPL's future direction across the decade and beyond, JPL Director Charles Elachi recently spoke about some of the forces that will shape the lab in the years ahead.

In looking at the plans for JPL's directorates, do you see any sharp turns? Or can we expect more gradual, steady evolution?

Sharp turns don't happen every year. But they can happen. A few years ago JPL developed a major focus on exoplanets. That was a significant turn—a whole new field, and a whole new technical capability emerged.

Looking ahead, a game changer will be the availability of NASA's Space Launch System that will provide a new capability for human exploration beyond Earth orbit. This is a much more powerful launch system than what exists today. It could have a dramatic impact on how we conceive of robotic missions to the outer planets as well. In the past we explored the outer planets with missions once every decade or so, but I think the SLS is going to open up the possibility for more frequent opportunities to travel to outer planets. Imagine if we were able to go to Jupiter or Saturn every two years, as we've been doing at Mars, where each mission builds on the knowledge of the previous one. For instance, let's say we go to Europa and we see geysers shooting everywhere. Two years later we send a lander, which will drill into the ice. Two or three years later we send a submarine. That would have been inconceivable without SLS, because currently it takes you six or seven years to get there.

Galaxy from the early universe

There was a lot of excitement this year when there was an announcement that JPL technology was involved in finding evidence of gravity waves in the very early universe. Will this work continue to be an important area for the lab?

When we learn more about how the universe started, that's not only scientifically exciting, but publicly exciting. There is a lot of fascination with how the universe we can see came about. And this is one of the most exciting things that JPL can follow up on because of the unique capability and technologies that we have. The findings announced this year were based on looking at a small piece of the sky. The next big step is to go 360 degrees. We can use the same technology, but instead of conducting it from the ground we want access to space to take measurements. I don't think we need any fundamental breakthrough inventions to accomplish this, but there are, of course, engineering challenges adapting it to space.

How about Earth science?

Remember, JPL's very first space mission was Explorer 1, an Earth-orbiting satellite that discovered the Van Allen radiation belt. Exploring our own planet is in our DNA. From early on we built both spacecraft and science instruments. The difference, I think, is that now we are being more deliberate in determining what are the fundamental questions about our planet that we need to solve. And that's telling us more about the kind of science instruments we need to build. This will be the way of the future for JPL in every field. For example, solving problems in Earth science is not only about the satellite and the instrument, it's about the quality of the science analysis, and having the talent to understand how you put everything together into a model and then verify that the model is correct. To do this, we are going to both bring aboard more scientific talent while building closer relationships with other organizations: universities, other government agencies, here in our country and abroad. It's a huge and complex undertaking.

How involved will JPL be with nano-satellites such as cubesats?

A few years ago we began using nano-satellites for mentoring and training. Now we see possibilities that they can be very beneficial for fast-track technology demos. They also could be a significant element in designing larger scientific missions. We are looking at ways we can use nano-satellites to increase the return from a mission to Europa or asteroid retrieval. On the Europa mission I sure hope we'll have room for four or five nano-satellites that could drop to the surface similar to how the Rangers were used at the moon back in the 1960s.

Do you feel everyone at JPL has a clear sense of where the lab is going?

I certainly want them to understand our goals, ambitions and dreams. It's vital for an organization like JPL that everyone sees where they fit in it, and more importantly, how they can contribute to the future. It's our talented staff who are going to be thinking of the innovative

NASA's Space Launch System

ways to implement our strategy. They're the ones who will appreciate what technologies will be needed to turn ideas into reality.

We always want to encourage people to come up with new ideas. We need to be looking not only at what we'll probably be doing in the next 10 years, but also what we'll be doing 20 years from now.

Shortly after our retreat I held a meeting with all of the lab's managers and briefed them in considerable detail on the path we see ahead of us. If people aren't sure about where we are headed, I encourage them to seek out their supervisor to see just how their job area fits into the larger picture of a very exciting future ahead of us.

News Briefs

Aquarius paper receives kudos

A paper on Aquarius, a JPL Earth-monitoring satellite that makes global observations of sea surface salinity, has been named the best paper published by the Institute of Electrical and Electronics Engineers' Transactions on Geoscience and Remote Sensing.

"L-band passive and active microwave geophysical model functions of ocean surface winds and application to Aquarius retrieval" was selected as winner of the IEEE Geoscience and Remote Sensing Society 2014 Transactions Prize Paper Award.

JPL co-authors are Simon Yueh, Wenqing Tang, Alexander Fore, Gregory Neumann, Akiko Hayashi, Adam Freedman, Mario Chaubell and Gary Lagerloef.

The award will be presented at the International Geoscience and Remote Sensing Symposium 2014 in July in Quebec City.

Gateway networking platform debuts

JPL Gateway, the Lab's internal professional networking and collaboration platform designed to connect colleagues and teams across JPL, will go live June 2.

A partnership between Human Resources and the Office of the CIO, Gateway is a key component of JPL's Workforce 2020 initiative. Gateway can be used to help locate expertise at JPL by making skills, past projects and directory data searchable via a personal profile. In addition, users and teams are provided with a personal online workspace that can be used to securely store, share and collaborate on files and folders.

Gateway's functionality allows for document version control, customized privacy settings as well as the ability to follow people, documents, groups, projects and conversations.

Visit https://gateway.jpl.nasa.gov.

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Honors for community service

More than 40 JPLers and 10 groups were have been honored for their volunteer efforts.

A recent recognition ceremony thanked those who gave of their time during National Volunteer Week the first week of April. Awards went to nominees who dedicated at least one full day of volunteer time and played an important role in an event or activity for JPL or their community.

JPL's Employee Involvement Committee organized the event. For more information, visit *https://gateway.jpl.nasa.gov/sites/EmployeeInvolvement/Volunteerism/Pages/Home.aspx.*

Passings

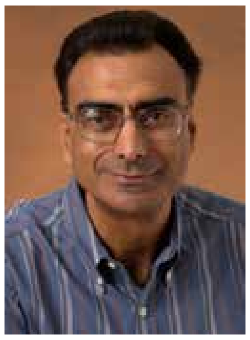
Elliott Sigman, 71, a hardware design engineer in the Tracking and Applications Section 335, died March 21.

Sigman had been a key member of the Processor Systems Development Group (335J), designing hardware for receivers and antenna arraying systems in the Deep Space Network.

Elliott Sigman

Sigman joined JPL in 1977 after working as a professor of electrical engineering at Harvey Mudd College. He was an expert in high-speed analog and digital circuits, especially analog-to-digital converters.

Sigman is survived by his brother Stanley, two nieces and a nephew. A memorial was held in Pasadena.



Jatinder Brar

Jatinder Brar, 61, chief information security officer in the Office of the CIO, died March 29.

Brar had been with JPL since 1985. An authority on cybersecurity, he managed JPL's Information Technology Security Process Office. He also served on the Chief Information Officer's Architecture and Standards Board.

Brar is survived by his daughter Jessica and partner Betty. Services were held April 9 at Forest Lawn in Glendale.

Patrick O'Brien, 67, a retired instrument specialist, died April 5.

O'Brien is survived by his mother, Marie; wife Katie and daughters Kelly and Shannon.

Services were held at Eternal Valley Memorial Park Mortuary in Newhall. O'Brien's family requests consideration of donations in his name to the Sunland/Tujunga American Legion or the Sunland/Tujunga Elks Lodge.

Pat O'Brien

Lew Allen Awards bestowed

From left: JPL Director Charles Elachi, Carmen Boening, David Thompson, Michael Mischna, JPL Chief Scientist Daniel McCleese. Honoree Abby Allwood is not shown.

Four JPLers were named recipients of the Lew Allen Award for Excellence, which recognizes significant individual accomplishments or leadership in scientific research or technological innovation by employees during the early years of their professional careers.

Here are the honorees:

Abigail Allwood, Planetary Chemistry and Astrobiology Group.

Allwood was selected for geobiology research and scientific leadership in Mars sample return, impacting direction of the Mars 2020 mission.

Carmen Boening, Climate Physics Group. Boening was selected for performing fundamental interdisciplinary research in climate science and coordinating research on sea-level rise prediction at JPL.

Michael Mischna, Earth and Planetary Atmospheres Group. Mischna was selected for leadership in Mars atmospheric science research that enables improved entry, descent and landing precision and advances in knowledge of Mars' climate history.

David Thompson, Machine Learning and Instrument Autonomy Group.

Thompson was selected for leadership of machine learning by autonomous robots and intelligent onboard analysis of large datasets.

Letters

I would like to thank my JPL family for all the support I received after the passing of my mom. It is difficult to express how touching everyone's comments on the cards and donations were to my family and me. Thank you also for the beautiful plant.

Carol Glazer

I would like to thank the JPL Instrument Cryogenics Group for the beautiful flowers delivered to my 99-year-old father's funeral last week. Also special thanks to JPL for the beautiful Dracena plant sent to us, and especially to Katy Villareal for coordinating the flower and plant gifts.

Jack Jones and Phuc Dao

Retirees

The following employees retired in May: **Kenneth Klaasen**, 41 years, Section 382E; **Nevin Bryant**, 40 years, Section 398; **Kathie Reilly**, 35 years, Section 2205; **Beatriz Abu-ata**, 33 years, Section 402; **Lauretta Rose Rosema**, 30 years, Section 272; **Pamela Distaso**, 28 years, Section 501; **Karen Buxbaum**, 25 years, Section 606; **Roberta Buckmaster**, 23 years, Section 605; **Randy Guthrie**, 23 years, Section 2111.