



W. M. KECK INSTITUTE FOR SPACE STUDIES

2024

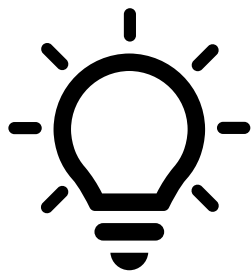
Annual Overview

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ABOUT KISS

The Keck Institute for Space Studies (KISS) was established at Caltech in January 2008 with an initial grant from the W. M. Keck Foundation. The Institute is a "think and do tank," that is shaping the future of space exploration, science, and technology via its three core objectives:



Develop ideas and concepts

that can revolutionize space science and engineering



Foster collaboration

Bridging Caltech and JPL, and integrating the world's space leaders into our community



Empower future leaders

of the space science and technology community

ABOUT KISS

This unique organization links the study elements of a think tank with the implementation elements of designing and developing prototypes. The Institute is centered on the intellectual, instrumentation, and research strengths of the Caltech Campus and JPL, and augments those strengths by inviting external experts from academia, government, and industry to engage in its programs.

The Institute also provides opportunities for graduate students and postdoctoral fellows to actively participate in cutting edge space mission research and learning.

The Institute supports significant outreach to the public and the wider technical/scientific community via open lectures and other events.

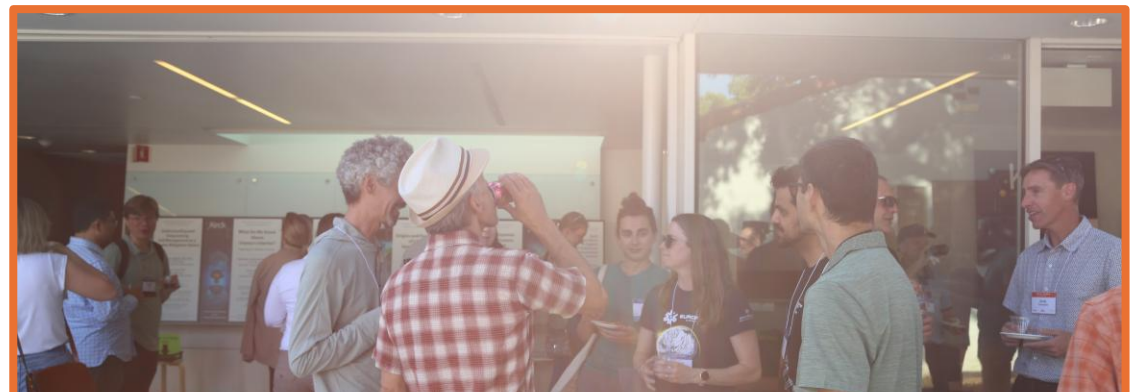


ABOUT KISS

At KISS we are dedicated to solving the most important and interesting space exploration problems of our time. We are at the forefront of new planetary, astrobiology, Earth, and astrophysics space mission concepts and technology. At KISS we:



Develop innovative science and technology concepts through our Study Programs



Build community through events



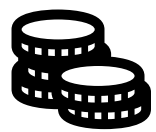
Inform and inspire through Public Lectures



Empower future space leaders through our Affiliate Program

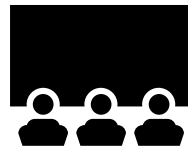
KISS IMPACT

KISS is recognized for its significant impact in many different areas:



\$285M+

Funding generated for KISS study participants to date



120+

workshops held to date

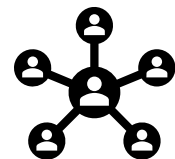


Creating new space missions and instruments



400+

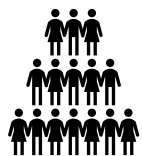
Research papers published



300+ organizations represented at KISS events



New technologies for space exploration



2,000+

participants in KISS studies, with many repeat attendees



30+ countries represented by workshop participants



Study recommendations influence national policy

2024 HIGHLIGHTS



**5 Study
Programs**



**8
Workshops**



**5 Short
Courses**



**1
Symposium**

2024 HIGHLIGHTS



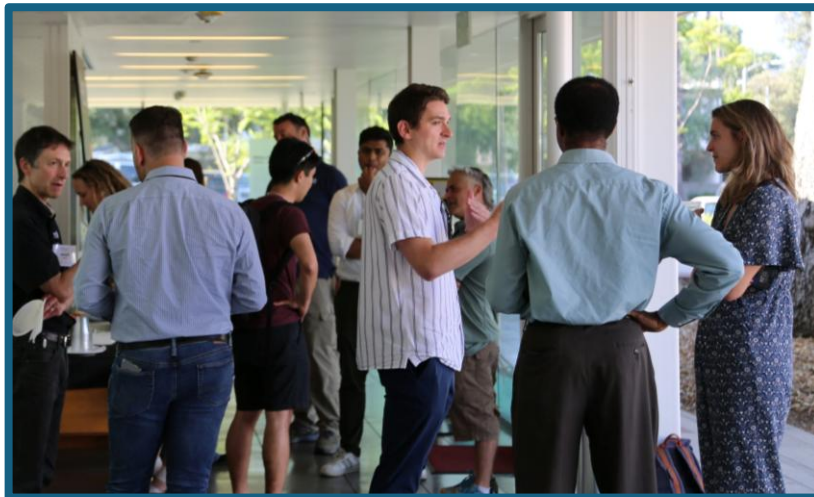
**3 Final
Reports
published**



**2 Public
Lectures**



**6 Affiliates
selected**



**Many
co-hosted
events**

2024 HIGHLIGHTS



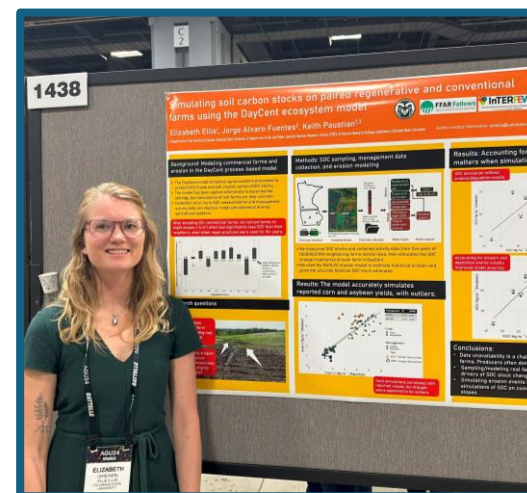
Ongoing
Impact



10+ Research
Papers
published



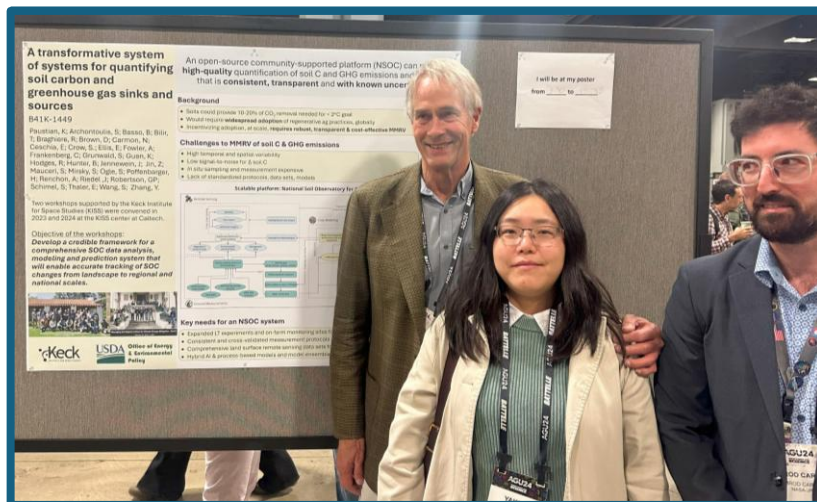
\$1M+ follow on
funding
awarded to KISS
studies in 2024



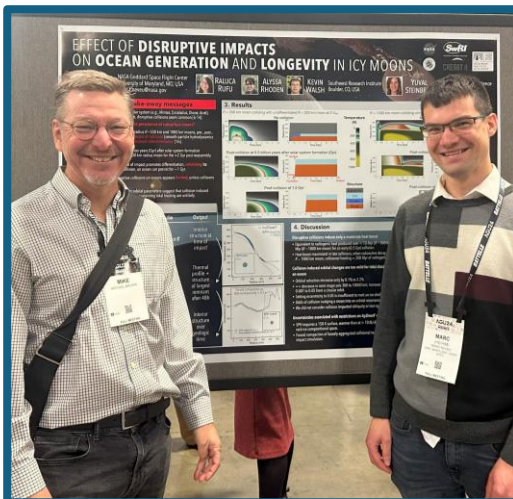
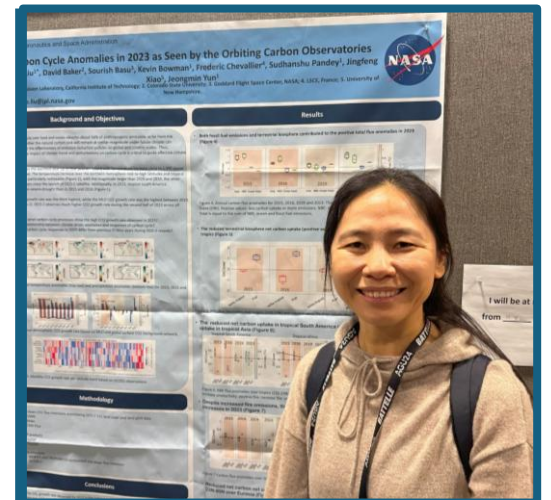
KISS continues
to act as a
springboard
fostering further
career
development

2024 HIGHLIGHTS

Numerous KISS studies represented at AGU2024



‘Revolutionizing Access to the Mars Surface’ KISS report (2020-2021) recognized as a key input to the NASA Mars Exploration Program 20-Year Plan



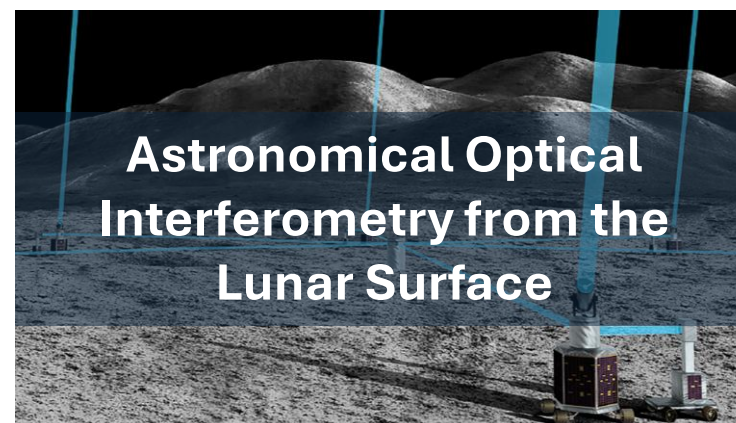
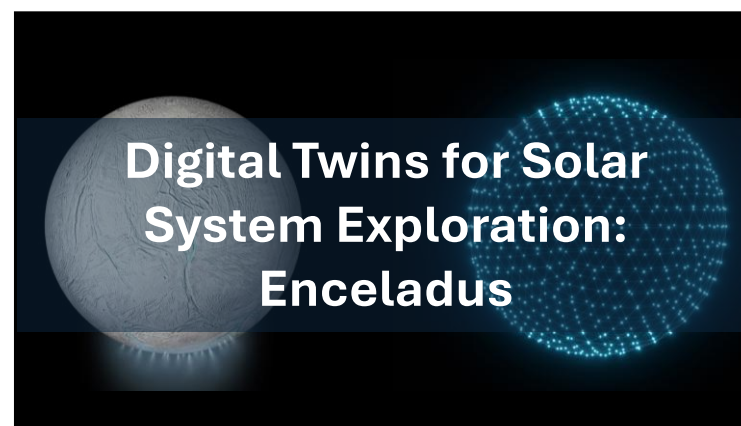
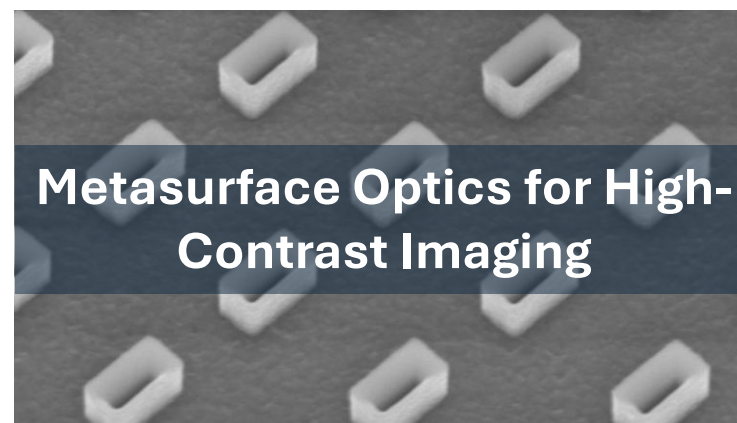
Climate Continuity (2022) KISS study recommendations presented to, and reflected in, the Earth Science Mid-Decadal Review



Multiple KISS study outcomes presented at the Mars 10 conference

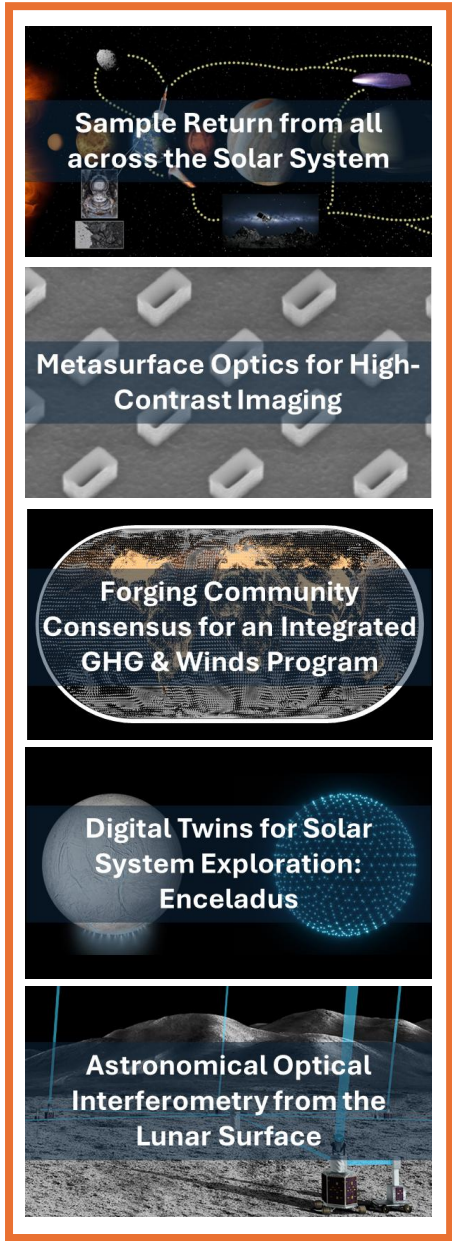
2024 STUDY PROGRAMS

2024 was another competitive year, with 26 study concepts followed by 11 full proposals received. 5 study programs were selected for the 2024 program.

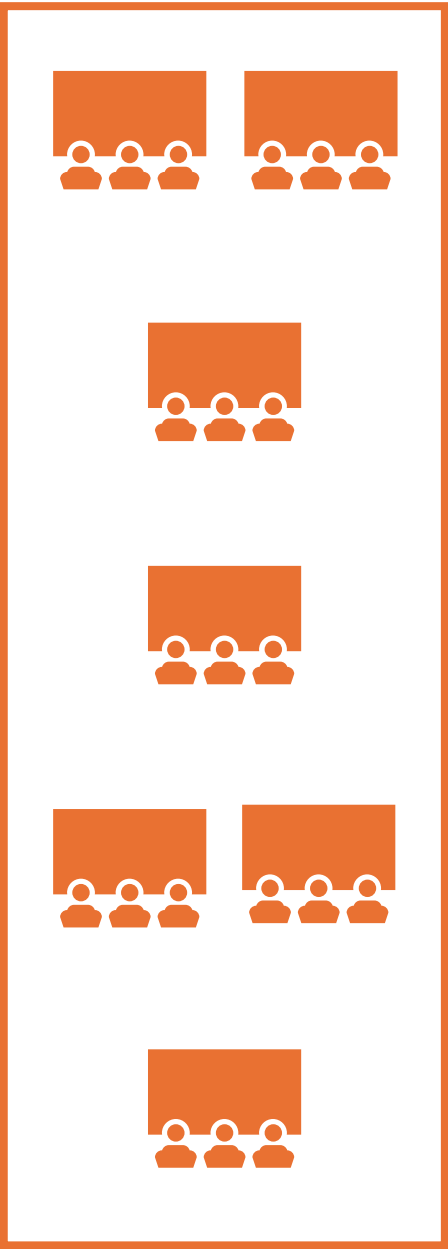


2024 STUDY PROGRAMS

5 Study Programs



7 Workshops



including



140+ Participants

representing



60+ Organizations



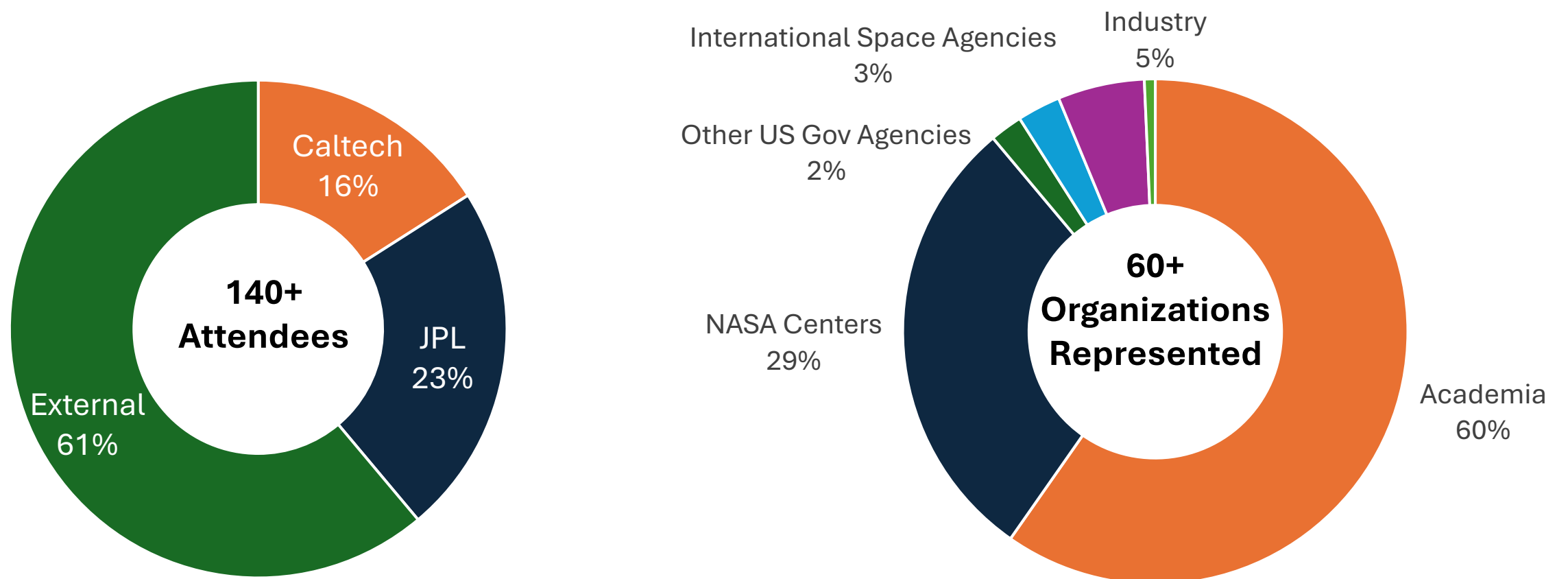
10 Countries

“This goes beyond simply exploring collaborative research; it is a unique opportunity to determine the direction of new research fields, something that cannot be accomplished within other frameworks.”

– workshop participant

2024 STUDY PROGRAM ATTENDEES

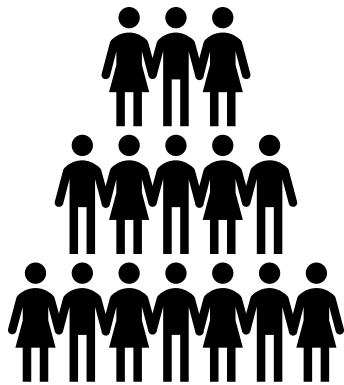
The Keck Institute for Space Studies brings together scientists and engineers from all over the world to participate in our study programs.



“The most valuable aspect was to gather various experts in science and engineering, coming from academia, industry, and agency. I felt that each expert had sharp and different knowledge in their own fields. This diversity helped us deepen the study topic at the workshop.”

– workshop participant

2024 STUDY PROGRAM ATTENDEES



24%

Of participants were graduate students and postdocs

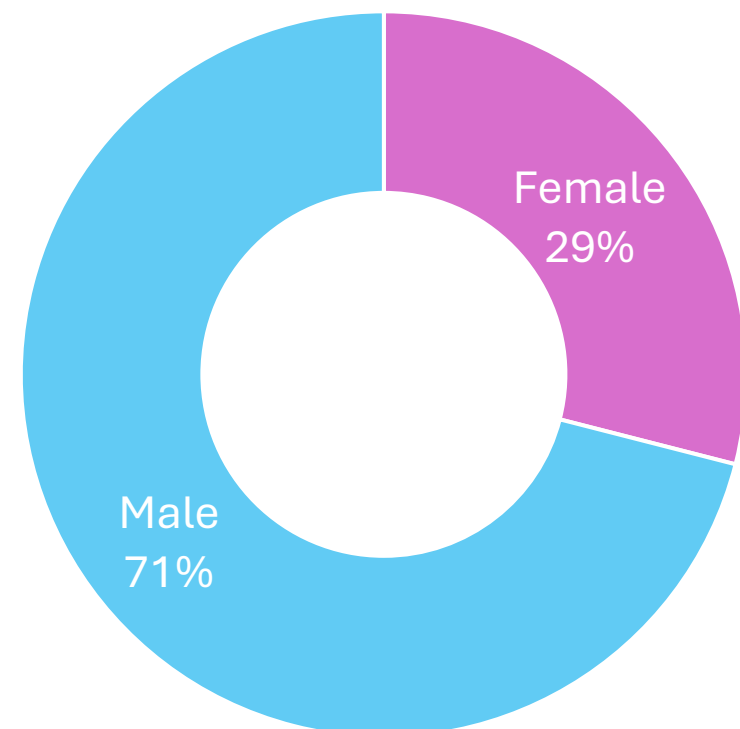
“The most valuable aspect of the study was the mix of early career and more senior members attending the workshop, in a small overall group. This helped everyone have a chance to voice their input / opinions on the study throughout the week.”

– workshop participant

“The workshop's interdisciplinary scope and productive discussions make it an invaluable resource, offering key references to guide the future of NASA's Heliophysics, Astrophysics, Planetary, and Earth Sciences.”

– workshop participant

Gender Diversity



SAMPLE RETURN FROM ALL ACROSS THE SOLAR SYSTEM



Study Leads: John Eiler (Caltech), Mathieu Choukroun (JPL), Hope Ishii (University of Hawai'i)

Participants: Aanu Adeloeye (University of Texas at Austin), Jose Aponte (NASA Goddard Space Flight Center), Lars Borg (Lawrence Livermore National Laboratory), Mike Brown (Caltech), Debra Buczowski (Johns Hopkins University Applied Physics Laboratory), Valentina Forero Fuentes (Hiroshima University), Anthony Freeman (JPL-Retired), Perry Gerakines (NASA Goddard Space Flight Center), Amy Hofmann (JPL), Reza Karimi (JPL), Jennifer Jackson (Caltech), Yang Liu (JPL), Jonathan Lunine (JPL), Karen Meech (University of Hawai'i), Alexander Meshoulam (Caltech), Kelly Miller (Southwest Research Institute), Angel Mojarro (NASA Goddard Space Flight Center), Marc Neveu (University of Maryland/NASA Goddard Space Flight Center), Ryan Ogliore (Washington University in St. Louis), Carol Raymond (JPL), Lee Saper (JPL), Lori Shiraishi (JPL), Shogo Tachibana (University of Tokyo), Francois Tissot (Caltech), Hikaru Yabuta (Hiroshima University), Teng Ee (Tony) Yap (Caltech), Michael Zolensky (NASA Johnson Space Center)



2
Workshops



30
participants



13
organizations



2 countries

SAMPLE RETURN FROM ALL ACROSS THE SOLAR SYSTEM

Study Objectives

This study will evaluate the science case for, and feasibility of, returning samples from the surface, atmosphere, and/or plumes of planetary bodies all across the Solar System, from Mercury to Kuiper Belt Objects beyond Pluto's orbit.

The planetary science community has fully entered the era of sample return from planetary bodies, following the recent successes of the Japan Aerospace eXploration Agency (JAXA) *Hayabusa 1 & 2* missions and NASA's *Origins, Spectral Interpretation, Resource Identification, and Security – Regolith Explorer (OSIRIS-REx)* mission. The Origins, Worlds and Life (OWL) Planetary Decadal Survey for the current 2023-2032 decade furthermore placed a very strong emphasis on sample return missions. Mars Sample Return is considered the highest priority mission for this decade. Sample return missions from the surface of a comet nucleus, and from Ceres, are among targets for upcoming rounds of New Frontiers missions.

Recent rocket technology advances (e.g. NASA's Space Launch System or the ongoing development of SpaceX's Starship), as well as emerging in-flight nuclear propulsion technologies (nuclear thermal propulsion, nuclear electric propulsion) will, when combined, enable the launch of spacecraft with sufficient propulsive power to reach previously unforeseen destinations with enough resources to carry a landed sampling platform and return samples back to Earth within a much shorter timespan than previously achievable.

Through this Study Program we anticipate ultimately arriving at a prioritized list of solar system targets for sample return missions for decades to come, based on the expected science return and technology readiness, and may provide recommendations for technology developments needed to enable such missions.

METASURFACE OPTICS FOR HIGH-CONTRAST IMAGING



Study Leads: J. Kent Wallace (JPL), Tobias Wenger (JPL), Dimitri Mawet (Caltech)

Participants: Olivier Absil (University of Liège), Vincent Chambouleyron (University of California, Santa Cruz), Niyati Desai (JPL), Jonathan Fan (Stanford University), Andrei Faraon (Caltech), Mikael Karlsson (Uppsala University), Lorenzo Koenig (JPL), Lisa Li (University of California, San Diego), Max Millar-Blanchaer (University of California, Santa Barbara), Thomas Milster (University of Arizona), Skyler Palatnick (University of California, Santa Barbara), Joon-Suh Park (Harvard University), Phillippe Pearson (Caltech), Emiel Por (Space Telescope Science Institute), Noah Rubin (University of California, San Diego), Maissa Salama (University of California, Santa Cruz), Jon Schuller (University of California, Santa Barbara), Eugene (Gene) Serabyn (JPL), Daniel Shanks (JPL), Yixuan Shao (Stanford University), Jamal Uddin (Coppin State University), Garrett West (BAE Systems Inc), Frederic Zamkotsian (Laboratoire Astrophysique Marseille)



1
Workshop



26
participants



14
organizations



4 countries

METASURFACE OPTICS FOR HIGH-CONTRAST IMAGING

Study Objectives

The workshop on "Metasurfaces for Exoplanet Detection and High-Contrast Imaging" aims to convene a diverse group of researchers, including end-users, designers, fabricators, and metrology experts, to explore and advance the application of metasurface optics in the field of astronomy and high-resolution imaging.

The goals of this workshop are:

1. Knowledge Exchange and Collaboration
2. Understanding Metasurface Optics in Astronomy
3. Showcasing Applications and Case Studies
4. Identifying Challenges and Exploring Solution
5. Networking and Future Collaborations

The ultimate goal of this workshop is to catalyze advancements in the field of metasurface optics specifically tailored for exoplanet detection and high-contrast imaging, fostering a collaborative environment that drives innovation, knowledge dissemination, and the translation of research findings into practical applications within the realm of astronomy and imaging technology.

FORGING COMMUNITY CONSENSUS FOR AN INTEGRATED GHG & WINDS PROGRAM



1
Workshop



28
participants



20
organizations



4 countries

Study Leads: *Mary Whelan (Rutgers University), Paul Wennberg (Caltech), Nick Parazoo (JPL)*

Participants: Arlyn Andrews (National Oceanic and Atmospheric Administration, NOAA), Michael Cartwright (University of Leicester/National Centre for Earth Observation), Roisin Commane (Columbia University), Edmond Cunningham (University of Massachusetts Amherst), Nikhil Dadheech (University of Washington), Kenneth (Ken) Davis (Pennsylvania State University), Christian Frankenberg (Caltech), Jonathan Franklin (Harvard University), Xueyuan (Eric) Gao (University of Maryland College Park), Jeremy Harrison (National Centre for Earth Observation), Gretchen Keppel-Aleks (University of Michigan), Le (Elva) Kuai (JPL), Junjie Liu (JPL), Julia Marshall (German Aerospace Center, DLR), Anna Michalak (Carnegie Institution for Science), Vijay Natraj (JPL), Louise Nuijens (Delft University of Technology), Derek Posselt (JPL), Bharat Rastogi (University of Colorado Boulder), Anastasia (Natassa) Romanou (NASA Goddard Institute for Space Studies), Andrew Schuh (Colorado State University), Daniel (Dan) Sheldon (University of Massachusetts Amherst), Patrick Walton (Care Weather Technologies Inc.), Fan Wu (Pennsylvania State University), Dien Wu (Caltech)

FORGING COMMUNITY CONSENSUS FOR AN INTEGRATED GHG & WINDS PROGRAM

Study Objectives

To respond to climate change effectively, we need better information about how planetary ecosystems are responding to changes in the environment through carbon-climate feedbacks. There are several dedicated greenhouse gas missions, current and planned, focused on observing changes in planetary greenhouse gas emissions from space; however, the ability to observe whether a reduction of emissions is attributable to a particular place, time, and process becomes entangled with the difficulties of observing concurrent changes in weather conditions. This gap prevents us from analyzing the impact of climate mitigation strategies and anticipating the fundamental interactions between the biosphere and climate change.

The overall goal of this KISS study on “Forging Community Consensus for an Integrated GHG and Winds Program” is to bring together expertise in wind observations and trace gas observation and attribution. Our work here will inform the design of a new satellite mission that will observe greenhouse gases and winds simultaneously. The resulting dataset will dramatically expand the boundaries of what is knowable about carbon-climate feedback through direct space-based observation. Workshop participants will determine together the questions that our group can answer in the near term and with new, future mission concepts.

DIGITAL TWINS FOR SOLAR SYSTEM EXPLORATION: ENCELADUS



Study Leads: Alphan Altinok (JPL), Eloïse Marteau (JPL), Mark Simons (Caltech), Krista Soderlund (UT Austin)

Participants: Daniel Abdulah (Massachusetts Institute of Technology), Michael Aivazis (PARASIM, INC), Amirhossein Bagheri (Caltech), Pau Batlle (Caltech), Andreas Benedikter (German Aerospace Center), Alexander Berne (Caltech), Diana Blaney (JPL), Amy Braverman (JPL), Sabrina Feldman (JPL), Lucas Fifer (University of Washington), Xiaojing Fu (Caltech), Peter Higgins (Harvard University), Terry Hill (NASA Headquarters), Wanying Kang (Massachusetts Institute of Technology), James Keane (JPL), Erin Leonard (JPL), Colin Meyer (Dartmouth College), Karl Mitchell (JPL), Dev Niyogi (University of Texas at Austin), Houman Owhadi (Caltech), Eitan Rapaport (Caltech), Matthew Siegler (University of Hawai'i), Manmeet Singh (University of Texas at Austin), Gregor Steinbruegge (JPL), Andrew Thompson (Caltech), Steven Vance (JPL)



2
Workshops



30
participants



11
organizations



2 countries

DIGITAL TWINS FOR SOLAR SYSTEM EXPLORATION: ENCELADUS

Study Objectives

A Digital Twin is a real-time virtual representation of a physical object, system, or process connected to its environment, which is dynamically updated with data from its physical twin throughout its lifecycle. While relatively new to planetary science, the Digital Twin concept has roots in industry and even in Earth Science which routinely develops Observing System Simulation Experiments (OSSEs) that attempt to closely couple physical models to measurement and mission design. The Study Team will first need to revisit this definition and to customize it for application to planetary mission formulation, focusing on all parts of a mission concept that directly impact science goals. For a Digital Twin to be useful it must be able to respond to new information and support decision-making. For our application, this new information would correspond to iterative modification of a mission instrument suite or concept of operations (ConOps) to satisfy science requirements and improve science return, it could also correspond to different realizations of the target body.

This KISS study program aims to define and develop the ability to simulate a proposed mission concept synthetically ahead of time, where the simulation includes the fundamental physical processes of interest, the characteristics of proposed observations (both intrinsic to any given instrument and how the measurement technique interacts with the physical environment), and finally the ConOps for the mission (e.g., acquisition strategy, orbital parameters, viewing geometry, mission duration, etc.). Our efforts will focus on the Saturnian moon Enceladus with a mindset to make the approach applicable to other bodies as well. The formulation of future planetary science missions would benefit from taking advantage of emerging modeling capabilities to quantify our ability to test key scientific hypotheses. These enhanced modeling efforts could include the ability to run scenario missions and allow one to test for data sufficiency.

OPTICAL ASTRONOMICAL INTERFEROMETRY FROM THE LUNAR SURFACE



1
Workshop



31
participants



23
organizations



5 countries

Study Leads: Gerard van Belle (Lowell Observatory), Shri Kulkarni (Caltech), Stuart Shaklan (JPL)

Participants: Tabetha Boyajian (Louisiana State University), Michelle Creech-Eakman (New Mexico Institute of Mining and Technology), John Elliott (JPL), Kimberly Ennico-Smith (NASA Ames Research Center), Daniel Hillsberry (Argo Space Corp), Kevin Hubbard (Honeybee Robotics), Takahiro Ito (Japan Aerospace Exploration Agency, JAXA), Connor Langford (University of Sydney), Laura Lee (Northern Arizona University), David Leisawitz (NASA Goddard Space Flight Center), Eric Mamajek (JPL), May Martin (European Space Agency), Taro Matsuo (Nagoya University), Dimitri Mawet (Caltech), John Monnier (University of Michigan), Jon Morse (Caltech), David Mozurkewich (Seabrook Engineering), Paul Niles (NASA Johnson Space Center), Mark Panning (JPL), Lori Pigue (U.S. Geological Survey), Aniket Sanghi (Caltech), Gail Schaefer (Georgia State University – CHARA), Jeremy Scott (University of Arizona), Locke Spencer (University of Lethbridge), Aaron Tohuvavohu (Caltech), Peter Tuthill (University of Sydney), Karel Valenta (University of Sydney), Jordan Wachs (Massachusetts Institute of Technology (MIT) / SpaceRake)

OPTICAL ASTRONOMICAL INTERFEROMETRY FROM THE LUNAR SURFACE

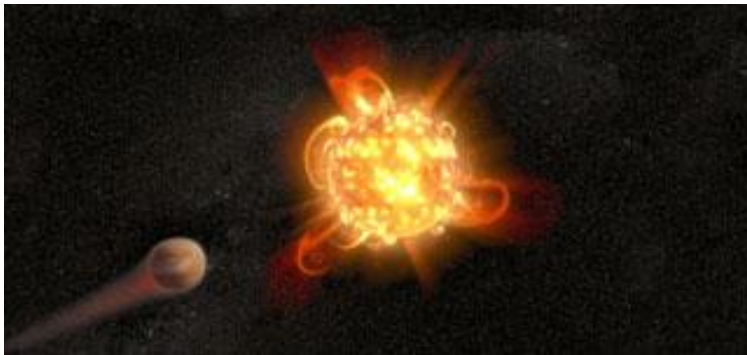
Study Objectives

The lunar surface is a compelling opportunity for large, distributed optical facilities, with advantages over orbital facilities for high-spatial-resolution scientific applications. Serious development of mission concepts is timely because of the confluence of two compelling factors: first, lunar access technology is maturing rapidly, in the form of both uncrewed and crewed landers of the Artemis program. Second, there has been a definitive maturation of astronomical optical interferometry technologies at Earth-based facilities over the past decade - opening windows on the universe previously inaccessible but limited by the Earth's atmosphere.

This KISS Study program will establish the feasibility of mission concepts that can be realistically developed in the near term, within existing funding lines. The compelling nature of milli- to micro-arcsecond resolution science in the ultraviolet, visible, and near-infrared will also be documented in the study report. Additionally, the workshop report will puncture myths about the lunar surface as a platform for astronomy.

By bringing together experts in the necessary, yet disparate, disciplines the specific opportunities afforded by lunar siting of interferometric telescopes can be highlighted. This convergence of expertise is necessary to achieve the interdisciplinary focus required for demonstrating the realistic, immediate achievability of pioneering facilities. The study program will highlight advances in the understanding of, and technology for, the lunar environment. This includes surface access, dust and thermal management, power and communication systems, and other issues. Specifically, the significant advantages for interferometer baseline management and simplification of input stations on the lunar surface will be demonstrated. Within this framework, the already demonstrated capabilities of Earth-based interferometric facilities can be realized on the lunar surface, amplifying those capabilities for significant gains against the goals of the Astrophysics Decadal Survey.

2nd Workshops of 2023 Studies held in 2024



Blazing Paths to Observing Stellar and Exoplanet Particle Environments - Part II

June 3 - 7, 2024

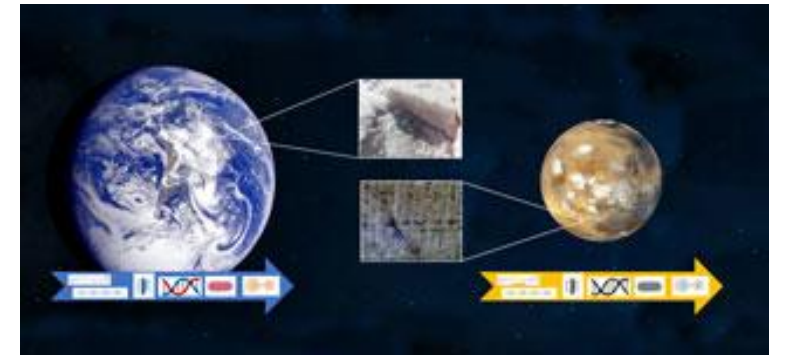
Building upon the promising ideas sparked at the inaugural Pathways to Observing Particle Environments of Stars and Exoplanets workshop, the second workshop convened four key working groups.



Managing Soil Organic Carbon for Climate Change Mitigation - Part II

February 26 - March 1, 2024

The objectives for the second workshop were to address technical challenges and identify opportunities for moving forward on each of four critical components.



The Biology of Biosignature Detection - Part II

January 29 - February 2, 2024

This workshop integrated the proposed ordained sets of experiments and biological measurements decided during the team's first workshop (July 2023) into the latter two goals for this workshop series.

3 REPORTS PUBLISHED IN 2024

AGU

ADVANCING
EARTH AND
SPACE SCIENCES

Earth's Future

RESEARCH ARTICLE
10.1029/2023EF003757

Key Points

- There is growing urgency for improved public and commercial services to support a resilient, secure, and thriving US
- Space-based Earth observations represent an essential component of the infrastructure needed to support the delivery of needed information
- The US would benefit from an overarching plan for sustained Earth observations to support our science, policy, and resilience goals

Supporting Information:
Supporting Information may be found in the online version of this article.

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Citation:
KISS Continuity Study Team (2024). Toward a US framework for continuity of satellite observations of Earth's climate and for supporting societal resilience. *Earth's Future*, 12, e2023EF003757. <https://doi.org/10.1029/2023EF003757>

Received 8 MAY 2023
Accepted 1 DEC 2023
Corrected 29 FEB 2024

This article was corrected on 29 FEB 2024. See the end of the full text for details.

Author Contributions:
Conceptualization: KISS Continuity Study Team
Methodology: KISS Continuity Study Team
Investigation: KISS Continuity Study Team
Writing original draft: KISS Continuity Study Team

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Toward a US Framework for Continuity of Satellite Observations of Earth's Climate and for Supporting Societal Resilience

KISS Continuity Study Team¹

¹See Appendix A

Abstract There is growing urgency for improved public and commercial services to support a resilient, secure, and thriving United States (US) in the face of mounting decision-support needs for environmental stewardship and hazard response, as well as for climate change adaptation and mitigation. Sustained space-based Earth observations are critical infrastructure to support the delivery of science and decision-support information with local, national, and global utility. This is reflected in part through the United States' sustained support of a suite of weather and land-imaging satellites. However, outside of these two areas, the US lacks an overarching, systematic plan or framework to identify, prioritize, fund, and implement sustained space-based Earth observations to meet the Nation's full range of needs for science, government policy, and societal support. To aid and accelerate the discussion on our nation's needs, challenges and opportunities associated with sustained critical space-based Earth observations, the Keck Institute for Space Studies (KISS) sponsored a multi-week think-tank study to offer ways forward. Based on this study, the KISS study team suggests the establishment of a robust coordination framework to help address US needs for sustained Earth observations. This coordination framework could account for: (a) approaches to identify and prioritize satellite observations needed to meet US needs for science and services, (b) the rapidly evolving landscape of space-based Earth viewing architecture options and technology improvements with increasing opportunities and lower cost access to space, and (c) the technical and programmatic underpinnings required for proper and comprehensive data stewardship to support a wide range of research and public services.

Plain Language Summary The Keck Institute of Space Studies has carried out a think tank study to codify best practices, articulate successes, and identify challenges and opportunities in the prioritization, acquisition, curation, and stewardship of sustained space-based Earth observations. The goal of the study is to accelerate discussion and plans for a greater and more impactful US contribution to the global satellite observing system that will support decision-making regarding climate change, environmental hazards, and national security. Based on this study, the KISS study team suggests the establishment of a nimble and responsive coordination framework to help guide and shepherd US concerns regarding sustained Earth observations. This coordination framework should account for: (a) approaches to identify and prioritize satellite observations needed to meet US needs for science and services, (b) the rapidly evolving landscape of space-based Earth viewing architecture options and technology improvements with increasing opportunities and lower cost access to space and (c) the technical and programmatic underpinnings required for proper and comprehensive data stewardship with a broad science and services user base in mind.

1. Introduction

Our environment is continually changing in ways that impact our lives and livelihoods. These environmental changes can be loosely categorized into two types: (a) rapidly evolving extreme events that impact a given location, and (b) slowly evolving regional-to-global-scale changes that occur from natural variations (e.g., El Niño) and/or anthropogenic forcing (e.g., land use/land cover changes, greenhouse gas emissions). Both types of changes are evident in Figure 1, which shows the number of billion-dollar environmental disaster events occurring in the US and their associated economic costs. Notable are the varied ways the environment can change in a matter of hours to days (e.g., severe storm, flooding, wildfire, freeze) to inflict heavy tolls on the US, its economy, and its citizens. Also illustrated in Figure 1 is a steady, unmistakable increase in the number of billion-dollar disasters affecting the US, with roughly a four-fold increase between the decades of the 1980s and the 2010s, with a commensurate increase in costs. There is ample evidence that changes in Earth's climate lie at the heart of the

KISS CONTINUITY STUDY TEAM

1 of 27

 Keck
INSTITUTE FOR SPACE STUDIES

TECHNOLOGY DEVELOPMENT

Ongoing technical development funded by KISS includes:

- “*Towards Low-Noise Microwave Amplifiers with Outstanding Room-Temperature Noise Performance*”, led by Austin Minnich and selected in 2023

Ongoing technical development facilitated by KISS includes:

- “*The Search for Water Worlds Around Nearby Stars*”, led by Heather Knutson selected in 2023 and funded by the Wilf Family Discovery Fund
- “*A Focal Plane Architecture for 3D Mapping of the THz Universe*”, led by Sunil Gowala (PMA) selected in 2024 and funded by the Wilf Family Discovery Fund

CAPTURING AN OPPORTUNITY AT APOPHIS



1
Symposium



25
participants



20
organizations



2 countries

Study Leads: Jose Andrade (Caltech), Carol Raymond (JPL), Adriana Daca (Caltech), Artur Chmielewski (JPL)

Participants: Paul Abell (NASA Johnson Space Center), Jim Bell (Arizona State University), Lance Benner (JPL), Rick Binzel (Massachusetts Institute of Technology), Katie Bouman (Caltech), Paul Chodas (JPL), Bjorn Davidsson (JPL), Rich Dekany (Caltech), Joseph DeMartini (University of Maryland), Jessie Dotson (NASA Ames Research Center), Charles Elachi (Caltech), Lorraine Fesq (JPL), Dathon Golish (University of Arizona), Mark Haynes (JPL), George Helou (Caltech), Toshi Hirabayashi (Georgia Institute of Technology), James Keane (JPL), Yaeji Kim (University of Maryland), Martin Laabs (Dresden University of Technology), Ryan Park (JPL), Dirk Plettemeier (Dresden University of Technology)

CAPTURING AN OPPORTUNITY AT APOPHIS

Symposium Objectives

Asteroid 99942, also known as Apophis, will make a close approach to Earth on April 13, 2029, coming within 31,860 kilometers of Earth (within the geostationary belt), presenting a unique opportunity to study its characteristics and trajectory, enhancing our understanding of near-Earth objects and planetary defense.


The symposium will focus primarily on evaluating the expected science return from a rendezvous mission to Apophis during its close Earth flyby that is being developed jointly by Caltech and JPL, along with industry partners. The science motivation for the mission focuses on what can be learned regarding the strength and interior structure of Apophis from observations before and after its closest approach, as well as an active bistatic radar experiment. The adequacy of the planned instruments and operational plan, and the feed forward into designing and modeling the deflection of a hazardous asteroid will be assessed. Suggestions for additional measurements that would enhance the science return will be considered. The objectives of this KISS symposium are to:

- Review what we can learn from specific measurements at Apophis and how they will advance the science of planetary defense, using the Small Bodies Assessment Group's Apophis Specific Action Team Report as a backdrop
- Provide guidance to the Apophis mission planning team at Caltech and JPL, to ensure the highest science return within cost and other constraints
- Define how the open data will be utilized to apply knowledge gained regarding the nature of rubble pile asteroids in general, and Apophis in particular to reduce modeling uncertainties in designing a future deflection attempt

Key outcomes of the Symposium will be:

- A set of recommendations to the mission team regarding the highest priority instrument capabilities and data products to exploit the Apophis close flyby opportunity and improve readiness for mitigating a hazardous asteroid
- A plan for follow-on activities to prepare for using the mission data to understand Apophis' interior and provide inputs to asteroid deflection modeling codes

ORIGINS AND EVOLUTION OF LIFE IN SPACE AND TIME



The Keck Institute for Space Studies
presents the following lecture:

Origins and Evolution of Life in Space and Time

Dr. James L. Green
Former NASA Chief Scientist

Wednesday, June 5, 2024

4:30 PM Refreshments
5:00 PM Lecture

Lees-Kubota Lecture Hall
California Institute of Technology

Join Dr. James L. Green as he discusses the origins and evolution of life in space and time. It is estimated that life started on Earth approximately 3.9 billion years ago. By studying the evolution of our own planet and Sun, it may give us some clues as to what to look for life at other locations in our own solar system and in the solar systems of other stars.

Comparative planetology tells us that terrestrial planetary atmospheres have been in a process of continual change within an ever changing solar and galactic environment. We are finding some startling parallels that suggest both Venus and Mars had environments that would have been habitable for life in their distant past. New observations in the outer part of our solar system indicate that Europa and Enceladus have an ocean of liquid water beneath their icy crust in contact with mineral-rich rock. These icy moons may have the ingredients needed for life as we know it.

With these discoveries, and many others in mind, we are looking for potentially habitable exoplanets and have made some significant discoveries.

For more information go to kiss.caltech.edu

seating is limited and is available on a first come, first served basis

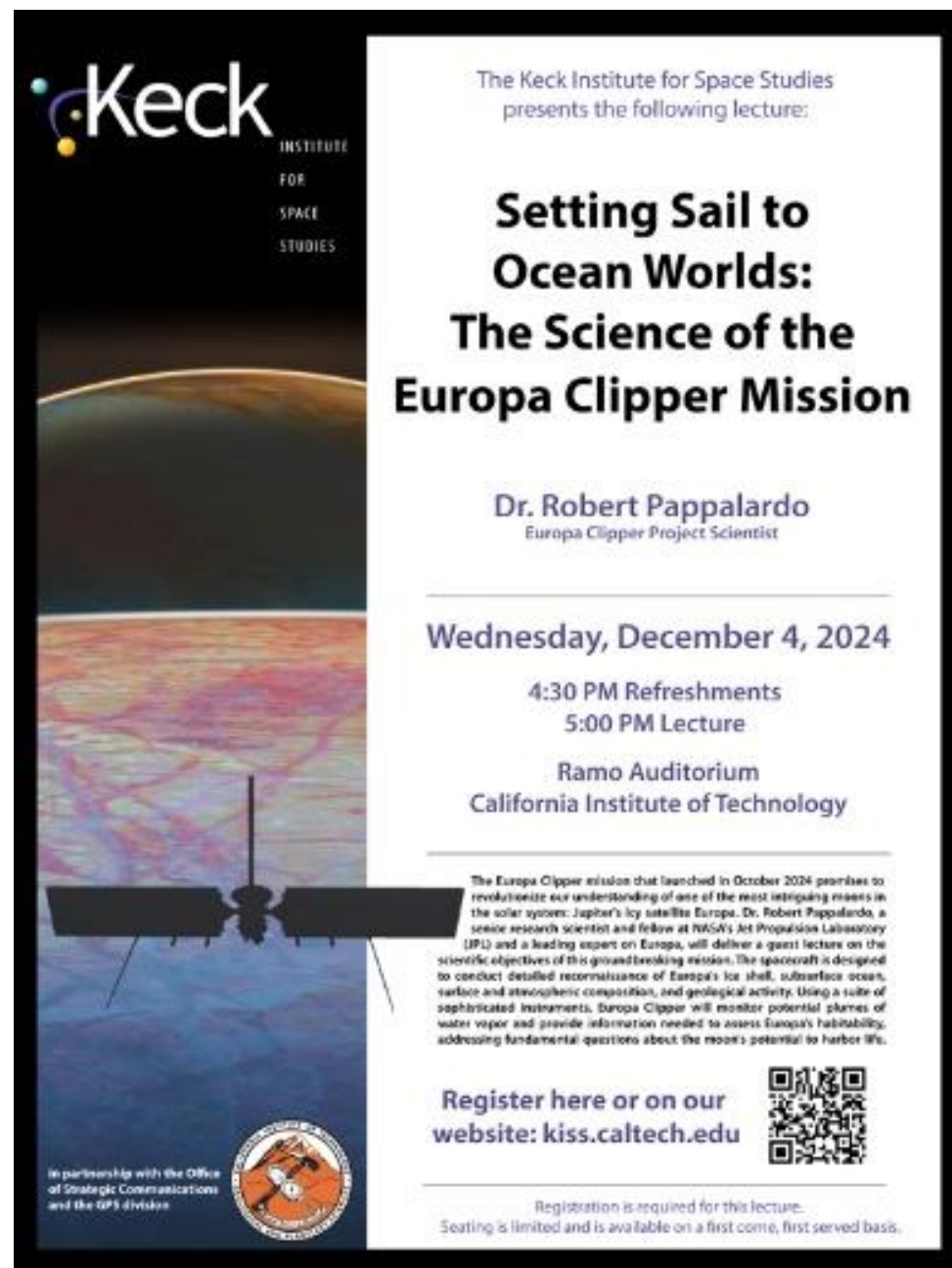


Jim Green

Former NASA Chief Scientist

Jim Green worked at NASA for 42 years before retiring in December 2022. During Jim's long career at NASA, he has been NASA's Chief Scientist and was the longest serving director of the Planetary Science Division with the overall programmatic responsibility for the New Horizons spacecraft flyby of Pluto, the Juno spacecraft to Jupiter, and the landing of the Curiosity rover on Mars.

SETTING SAIL TO OCEAN WORLDS: THE SCIENCE OF THE EUROPA CLIPPER MISSION



The Keck Institute for Space Studies
presents the following lecture:

Setting Sail to Ocean Worlds: The Science of the Europa Clipper Mission

Dr. Robert Pappalardo
Europa Clipper Project Scientist

Wednesday, December 4, 2024

4:30 PM Refreshments
5:00 PM Lecture

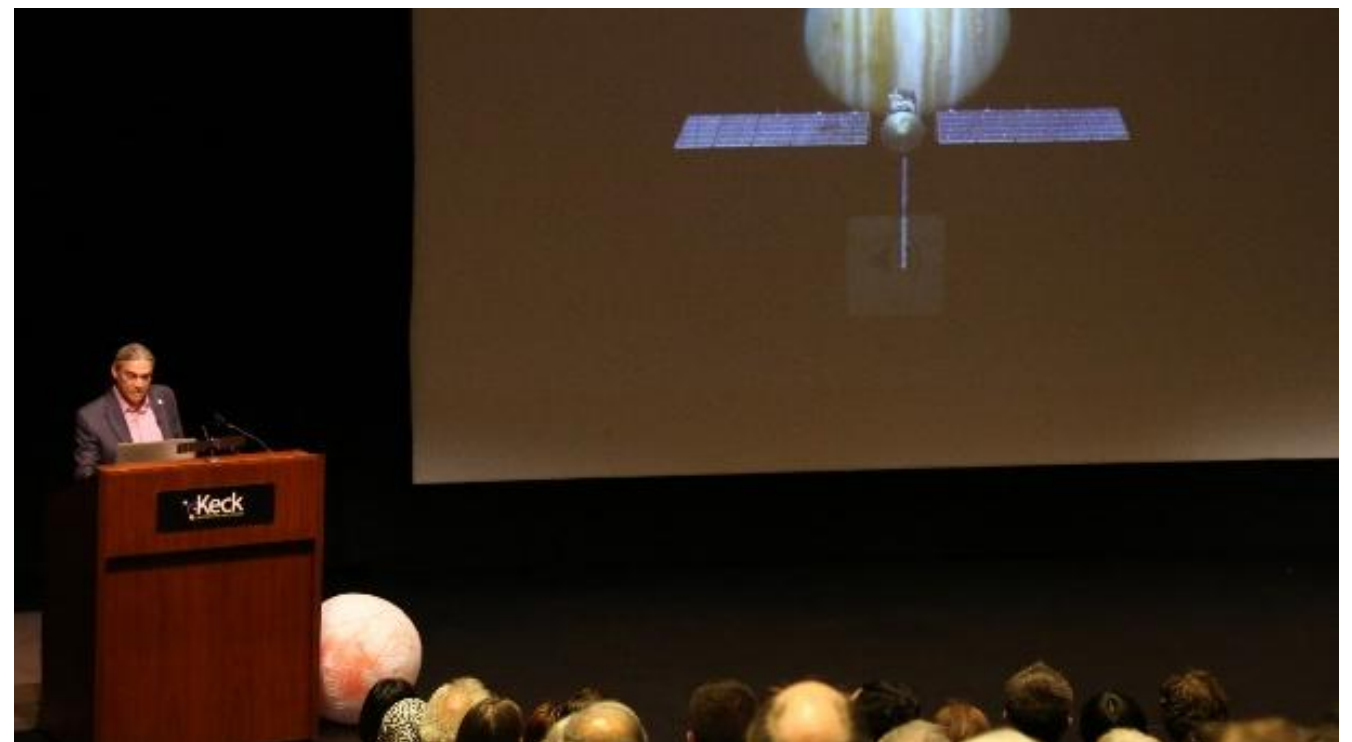
Ramo Auditorium
California Institute of Technology

The Europa Clipper mission that launched in October 2024 promises to revolutionize our understanding of one of the most intriguing moons in the solar system: Jupiter's icy satellite Europa. Dr. Robert Pappalardo, a senior research scientist and fellow at NASA's Jet Propulsion Laboratory (JPL) and a leading expert on Europa, will deliver a guest lecture on the scientific objectives of this groundbreaking mission. The spacecraft is designed to conduct detailed reconnaissance of Europa's ice shell, subsurface ocean, surface and atmospheric composition, and geological activity. Using a suite of sophisticated instruments, Europa Clipper will monitor potential plumes of water vapor and provide information needed to assess Europa's habitability, addressing fundamental questions about the moon's potential to harbor life.

Register here or on our website: kiss.caltech.edu

Registration is required for this lecture.
Seating is limited and is available on a first come, first served basis.

In partnership with the Office of Strategic Communications and the GPS division



Bob Pappalardo
Europa Clipper Project Scientist

Robert Pappalardo is a Project Scientist, JPL Fellow, and Senior Research Scientist in the Planetary Science Section of JPL's Science Division. As an affiliate member of the Galileo Imaging Team while a researcher at Brown University, he worked to plan many of the Galileo observations of Jupiter's icy Galilean satellites.



Caltech - JPL Mixer

July 11, 2024

Caltech

Keck
INSTITUTE FOR SPACE STUDIES

JPL

CALTECH – JPL MIXER

This mixer was designed to bring together 140+ Campus faculty and JPL researchers who are interested in collaborating on topics of mutual interest. This event enabled Caltech faculty to interact with JPL researchers with the goal to build strong and diverse joint research programs in the fields of Earth and Space Science, and Technology.

The hope is that this networking mixer opens possibilities for joint research beginning with opportunities through the Keck Institute for Space Studies, the JPL Researchers On Campus (JROC), President's and Director's Research and Development Fund (PDRDF), the Brinson Exploration Hub, and other relevant programs.

The reception was hosted by the JPL Office of Research and Development and the Keck Institute for Space Studies.



NASA Summer School on Satellite Observations and Climate Models



August 5 – 9, 2024

Each year, the JPL Center for Climate Sciences hosts a summer school at the Keck Center that brings together the next generation of climate scientists - about 30 graduate students and postdocs from around the world - to engage with premier climate scientists from the Jet Propulsion Laboratory and elsewhere. This yearly summer school focuses on topics on the leading edge of climate science research.

JOURNEYS AT MARS



The Tenth International Conference
on Mars presents:

Journeys at Mars: Discoveries and Future Exploration

Wednesday, July 24, 2024
6:00 PM Exhibition
7:00 PM Panel

Beckman Auditorium
California Institute of Technology

Join experienced Mars scientists for a discussion on the future of Mars. The panel will speak from their personal perspectives about the most important discoveries from the Red Planet, and what they believe is next for Mars exploration!


The panel includes:

Dr. Noora Alsaeed, UAE Space Agency, Senior Space Science Researcher, and member of the Emirates Mars Mission 'Hope' team
Dr. Philip Christensen, Arizona State University (ASU), PI of the Thermal Emission Imaging System on the Mars Odyssey spacecraft, and co-chair of the National Academies Decadal Survey of Planetary Science and Astrobiology
Dr. François Forget, Research Director of the French National Center for Scientific Research (CNRS) and member of the French Academy of Sciences
Dr. Abigail Fraeman, JPL, Deputy Project Scientist of the Mars Science Laboratory, and Mars Exploration Rovers
Dr. Mini Wadhwa, ASU, Mars Sample Return Principal Scientist, and member of the National Academy of Sciences
Dr. Jessica Watkins, NASA astronaut with over 170 days in space, and a Mars research scientist

The evening will begin at 6:00 p.m. with family-friendly activities and displays of spacecraft models, and the discussion will begin at 7:00 p.m.

THE TENTH
INTERNATIONAL
CONFERENCE
ON MARS

10





Public panel discussion during the Mars 10 conference including:

- **Professor Bethany Ehlmann** – Caltech (*moderator*)
- **Dr. Noora Alsaeed** – UAE Space Agency
- **Dr. Philip Christensen** – Arizona State University
- **Dr. François Forget** – French National Center for Scientific Research
- **Dr. Abigail Fraeman** – JPL
- **Dr. Mini Wadhwa** – Arizona State University
- **Dr. Jessica Watkins** - NASA

KISS AFFILIATE PROGRAM

Nominated by the Caltech faculty, KISS Affiliates are an ongoing cohort of Campus graduate students and postdocs who are seen as the next generation of space exploration leaders.

Many KISS Affiliates share that their interactions with the Institute and the people they meet through the Institute comprise some of their best experiences at Caltech.

KISS provides them unique experiences with industry CEOs, astronauts, space mission leaders, NASA leadership and world-renowned space exploration researchers.



2024 KISS AFFILIATES



Zac Ahmad
EAS grad student



Samantha Baker
GPS grad student



Valeria Kachmar
GPS grad student



Zachariah Milby
GPS grad student



Aniket Sanghi
PMA grad student



Marlini Simoes
EAS postdoc

KISS AFFILIATE 2024 PROGRAM



Nadine Soliman Astro on Tap, March 2024



Site visit of Honeybee Robotics, April 2024



Sorina Lupu, Finalist, Caltech 3MT, April 2024



Meeting JPL Director & Deputy Director, Laurie Leshin and Leslie Livesay, at the Muses of the California Science Center



Lunch with Maggie Yancey, Entrepreneurship Lead NASA SMD/STMD, May 2024



Fireside Chat with Clay Mowry, May 2024



Dinner with Jim Green, former NASA Chief Scientist, June 2024

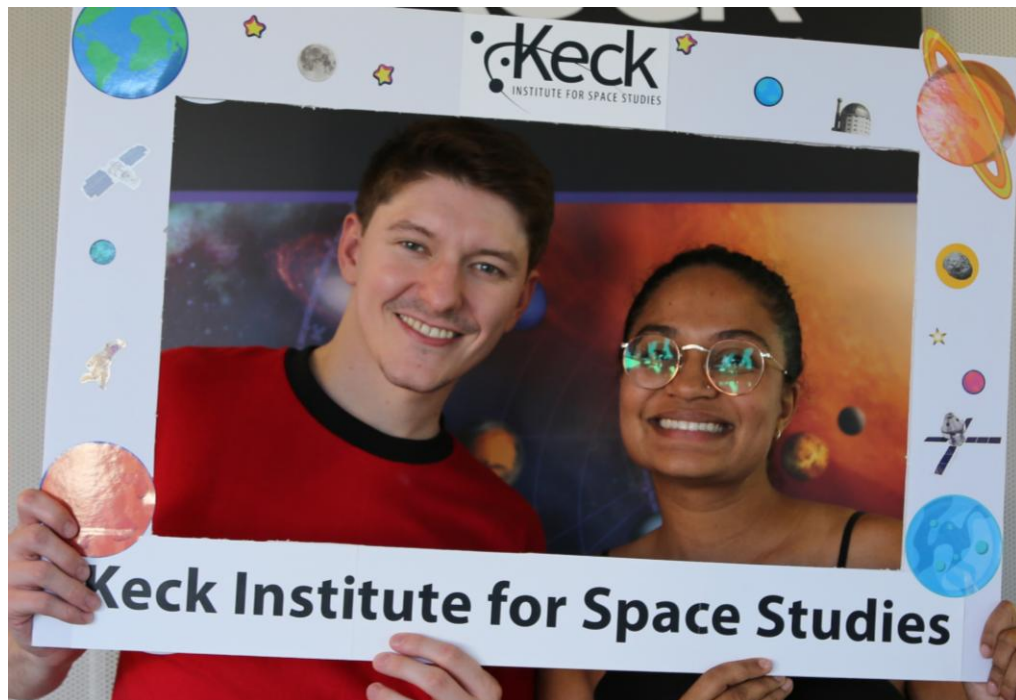


Affiliates Summer Soiree, August 2024



Dinner with Bob Pappalardo, Europa Mission Project Scientist, December 2024

KISS AFFILIATE PROGRAM

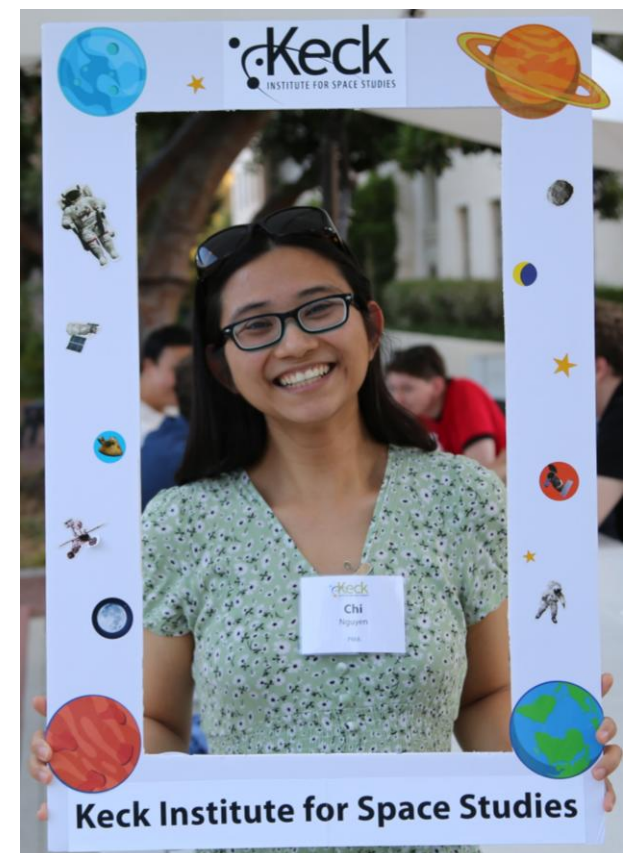


“KISS has provided me with a cohort of other students with similar interest but with new ideas stemming from our distinct backgrounds & fields.”

Zac Ahmad, Grad Student (Caltech-EAS), KISS Affiliate 2024

“KISS has given me a community of like-minded young motivated professionals. The program also provides me with the opportunities to develop my networking skills & to meet with leaders of space industry.”

Chi Nguyen, Postdoc (Caltech-PMA), KISS Affiliate 2023



KISS AFFILIATE PROGRAM

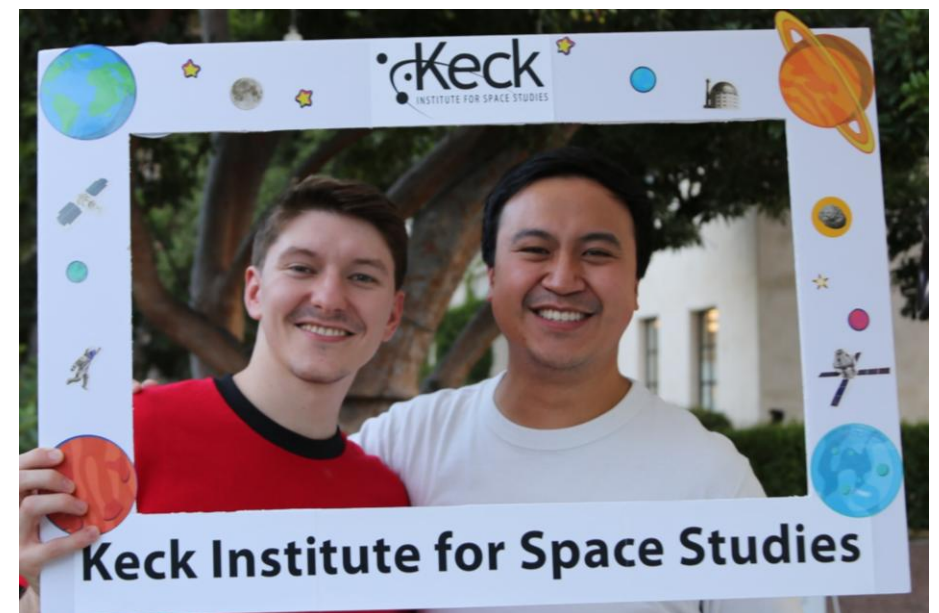


“Belonging to KISS has been my best experience at Caltech-NASA/JPL!!! Come and learn/share with us!”

Marlini Simoes, Postdoc (Caltech-EAS), KISS Affiliate 2024

“KISS has been an amazing way to be involved in space-related activities! It’s been amazing to see all different parts of space sciences come together!”

Kevin Yu, Grad Student (Caltech-EAS), KISS Affiliate 2023



KISS AFFILIATE PROGRAM



“KISS has pushed me to seek out and try challenges and opportunities I wasn’t sure I could do. Thanks to that, I’ve won a grant that will take me to a conference in Italy.”

James Ragan, Grad Student (Caltech-EAS), KISS Affiliate 2021

“KISS is an awesome community that creates meaningful relationship lasting way longer than our time at Caltech.”

Christophe Leclerc, KISS Graduate Student Fellow 2015



KISS STAFF



Bethany Ehlmann
Director



Harriet Brettle
Executive Director
(started April 1)



Janet Seid
Senior Program
Manager



Antonio Soriano
Events and Web
Content Coordinator



Patama Taweesup
Grants Manager



Jordan Patton
Event Assistant

KISS STEERING COMMITTEE

The Steering Committee includes representatives from Caltech and JPL, providing guidance and expertise on KISS activities, including the technical review of KISS study programs.



Jack Beauchamp
Caltech



Becky Castano
JPL



Tom Cwik
JPL



George Djorgovski
Caltech



Charles Lawrence
JPL



Rosaly Lopes
JPL



Jonathan Lunine
JPL (incoming)



Austin Minnich
Caltech



Jessica Neu
JPL



Sue Owen
JPL (outgoing)



Mark Simons
Caltech



Yuk Yung
Caltech

