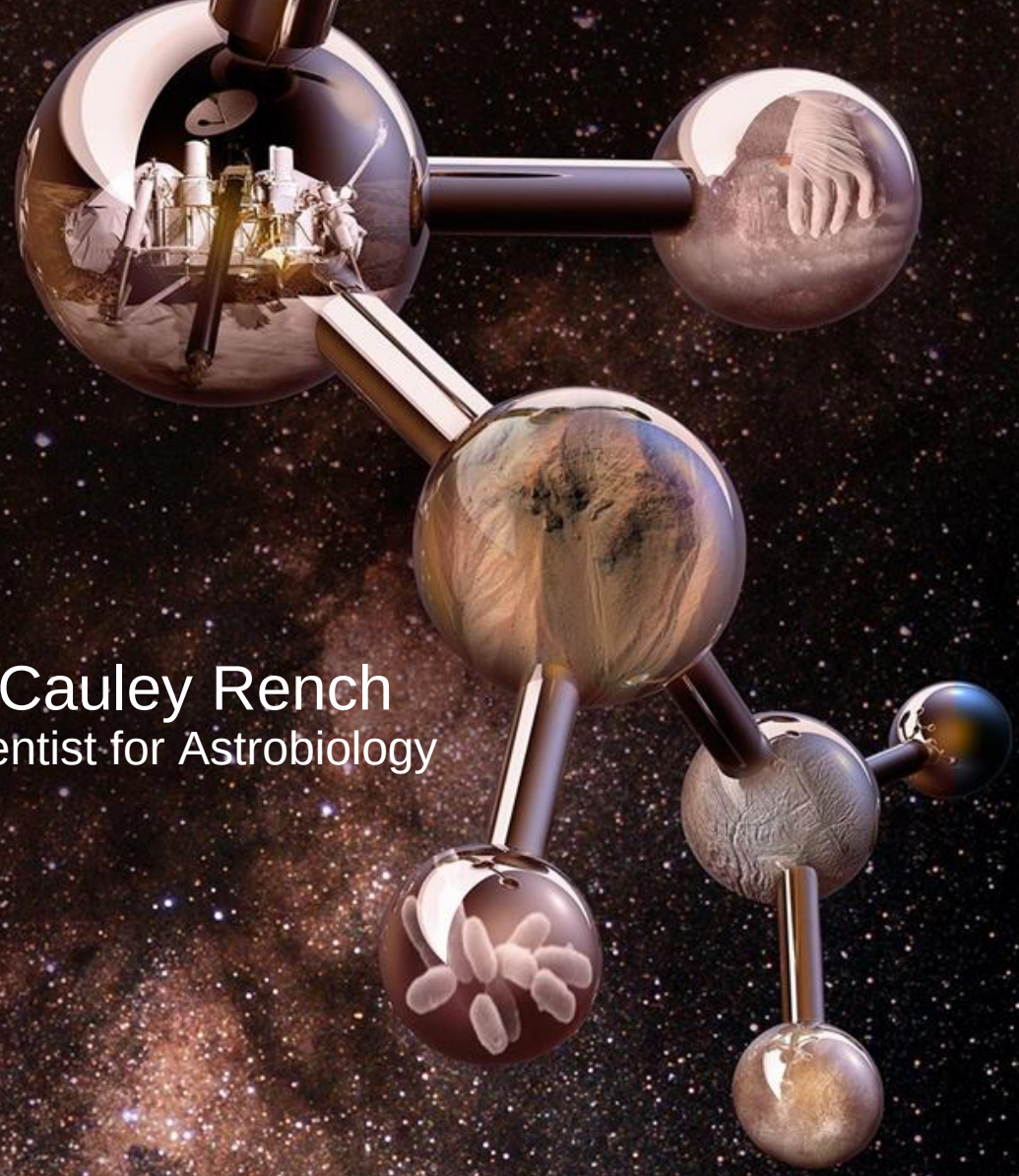
# NASA Astrobiology Program Update



David Grinspoon
Senior Scientist for Astrobiology Strategy

Becky McCauley Rench
Program Scientist for Astrobiology (Acting)

Committee on Astrobiology and Planetary Science
October 21, 2024

# New Astrobiology Program Leadership

Senior Scientist for Astrobiology Strategy (David Grinspoon):

"Up and out": expand the astrobiology program within NASA and beyond

Program Scientist for Astrobiology *(Acting)* (Becky McCauley Rench)

"Down and in": manage existing Astrobiology research and coordination programs

Congratulations to Lindsay Hays in her new role as Senior Scientist for Mars Exploration!!

# Astrobiology Research Coordination Networks

- Going forward, RCN co-leads and the RCN activities will be supported by grants to support each RCN and the NASA Astrobiology Program will provide a support person (details on next slide)
- Individual PIs to ROSES programs can include budget to support their involvement in the RCNs

# New RCN Support Liaison Hired!

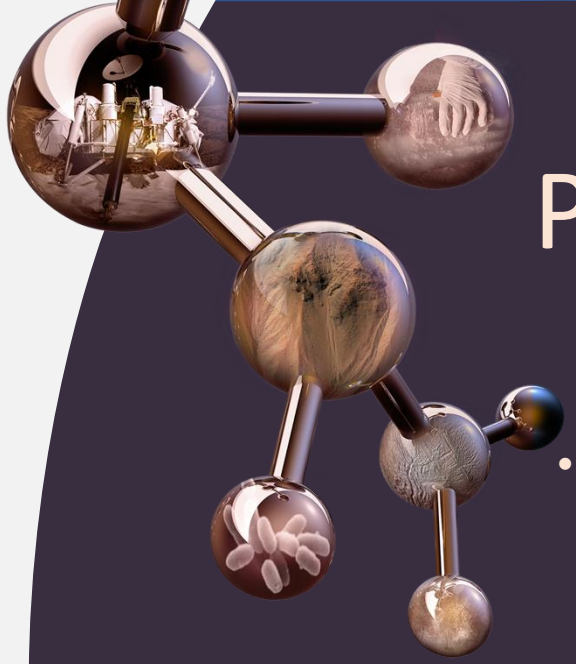
- **Major goal with Astrobiology RCNs:** Reduce administrative burden on co-leads so they can focus on the intellectual leadership of their networks
- Duties include:
  - Coordinating with co-leads and team leads for the planning and organizing of events and workshops.
  - Managing internal and external communications
  - Mailing list maintenance
  - Maintain and update web pages and social media posting
  - Newsletter crafting and dissemination
  - Maintaining calendars and spreadsheets for upcoming events, supporting webinars hosted through Zoom, YouTube, Microsoft Teams, etc.
  - Working with NASA and RCN members to maintain updated membership lists.

Willow Houck,
RCN
Support Liaison

# Astrobiology Research Programs

- C.5 Exobiology (PO: Alison Olcott, HQ-EXO@mail.nasa.gov) **NEW**
  - Aim is to understand the origin, evolution, distribution, and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere.
- F.4 Habitable Worlds (HW) (PO: Becky McCauley Rench, HQ-HW@mail.nasa.gov
  - Aim is to use knowledge of the history of the Earth and the life upon it as a guide for determining the processes and conditions that create and maintain habitable environments and to search for ancient and contemporary habitable environments and explore the possibility of extant life beyond the Earth.
  - **Final call in ROSES-2024**
- C.14 Planetary Science and Technology Through Analog Research (PSTAR) (PO: Becky McCauley Rench, HQ-PSTAR@mail.nasa.gov)
  - This program solicits proposals for investigations focused on exploring the relevant environments on Earth in order to develop a sound technical and scientific basis to conduct astrobiological research on other Solar System bodies.
- C.20 Interdisciplinary Consortia for Astrobiology Research (ICAR) (PO: Becky McCauley Rench, HQ-ICAR@mail.nasa.gov) **NEW**
  - Proposals that describe a multi-million dollar, five-year project with an interdisciplinary approach to a single, compelling question in astrobiology. For projects larger than the scope of the individual research programs, but within the scope of the Research Coordination Networks.
- F.3 Exoplanet Research Program (XRP) (PO: John Wisniewski, HQ-XRP@mail.nasa.gov)
  - This program solicits basic research proposals to conduct scientific investigations that significantly improve our understanding of exoplanets and exoplanet formation.

Alison Olcott,
Program Officer



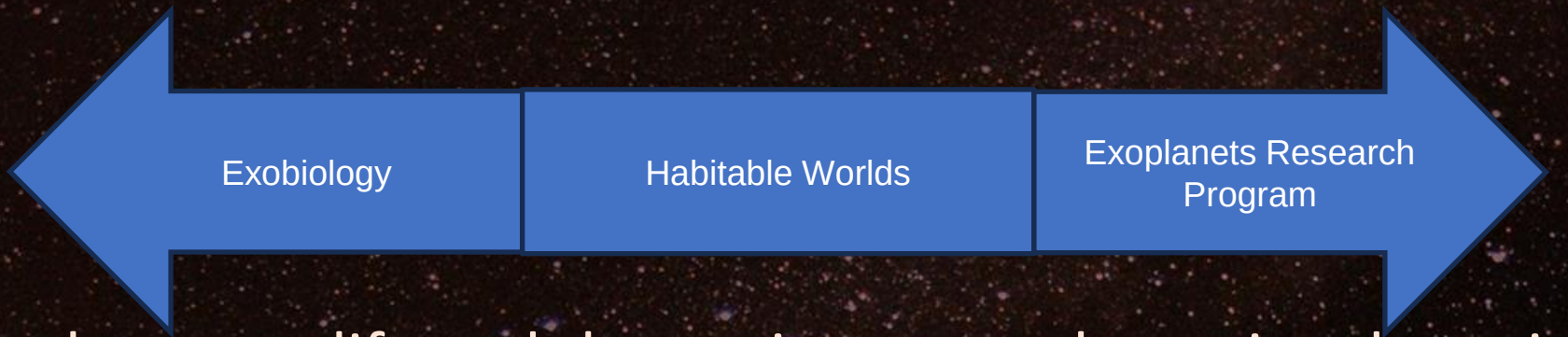
# PSTAR Scope Change

- In ROSES-25, the PSTAR solicitation will expand to allow both planetary science and astrobiology-focused research proposals.
- The solicitation and peer review process will be combined.
- The budgets for astrobiology-focused research will remain separate and within the Astrobiology Program portfolio.

# Redistribution of Habitable Worlds

- ROSES-2024 will be the last year we solicit Habitable Worlds (HW), but this will not change the scope of the proposals being solicited
- Starting in ROSES-2025, the scope of proposals that would have previously been submitted to HW should now be submitted to Exobiology (EXO) and Exoplanets Research Program (XRP)
- In general, we anticipate that ~90% of proposals that would have been submitted to HW will now be submitted to EXO

# ROSES-2025: EXO and XRP




ROSES-24

- The line between life and the environment that existed previously between EXO and HW will disappear
- The line between observations and theory of habitability of exoplanets that existed previously between XRP and HW will disappear


ROSES-25

# ROSES-2025: EXO and XRP (cont)

- Exobiology will continue to be the primary call for astrobiology focused research proposals, including understanding biosignatures.
  - Exobiology proposals do not require connection to current or future NASA missions or direct observations from those missions.
- XRP will continue to be the primary call for exoplanet focused research proposals.
  - XRP proposals do require connection to current or future NASA missions or direct observations from those missions.
- Proposals that include both topics should be submitted to the program that covers the majority of the proposed research and include a relevance statement that describes this to be the case.

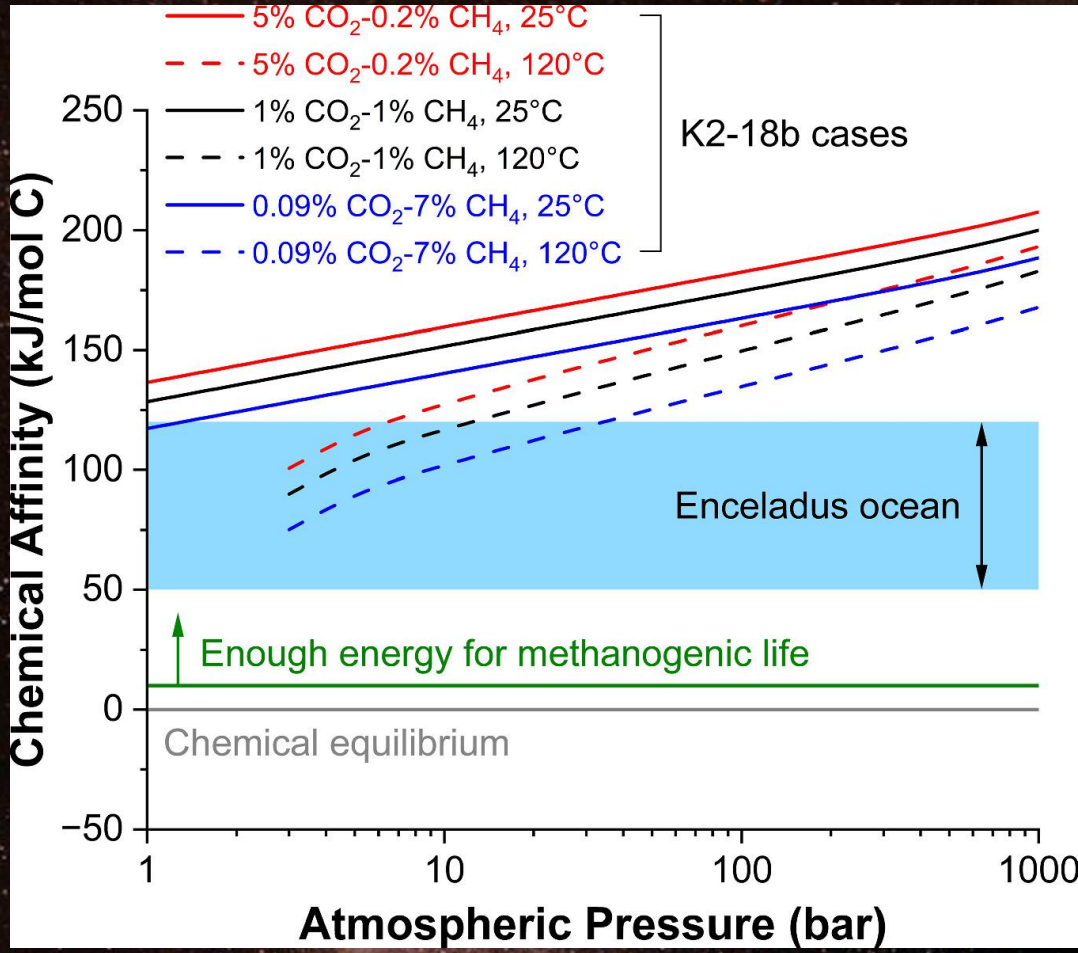
# ICAR - Interdisciplinary Consortia for Astrobiology Research

- ICAR is solicited in ROSES-24
- Step-1 proposals were due Sept 24, 2024
- Step-2 proposals are due Jan 16, 2024

# Astrobiology – Research Highlight
# PI: Chris Glein

**What do JWST measurements of the atmospheric composition of K2-18b tell us about potential habitability?**

- **Methods:** Bioenergetic calculations to constrain how far different methane and amino acid synthesis reactions might be from chemical equilibrium.
- **Result:** Metabolic reactions that consume hydrogen gas from the atmosphere are strongly favored for the previously proposed case where K2-18b has a liquid water ocean at its surface. Putative microorganisms could take advantage of these reactions to obtain energy—one of the key requirements of life as we know it. This suggests that there are conditions at which this planet would be habitable.
- **Implications:** This work helps us to understand potential paths to habitability on a new class of planets, called hycean worlds. These planets are hypothesized to have hydrogen-rich atmospheres on top of liquid water oceans. If they exist and K2-18b is a relevant example, then my calculations indicate that hycean worlds would be favorable environments to support methanogenic metabolisms and organic synthesis, including the synthesis of amino acids.

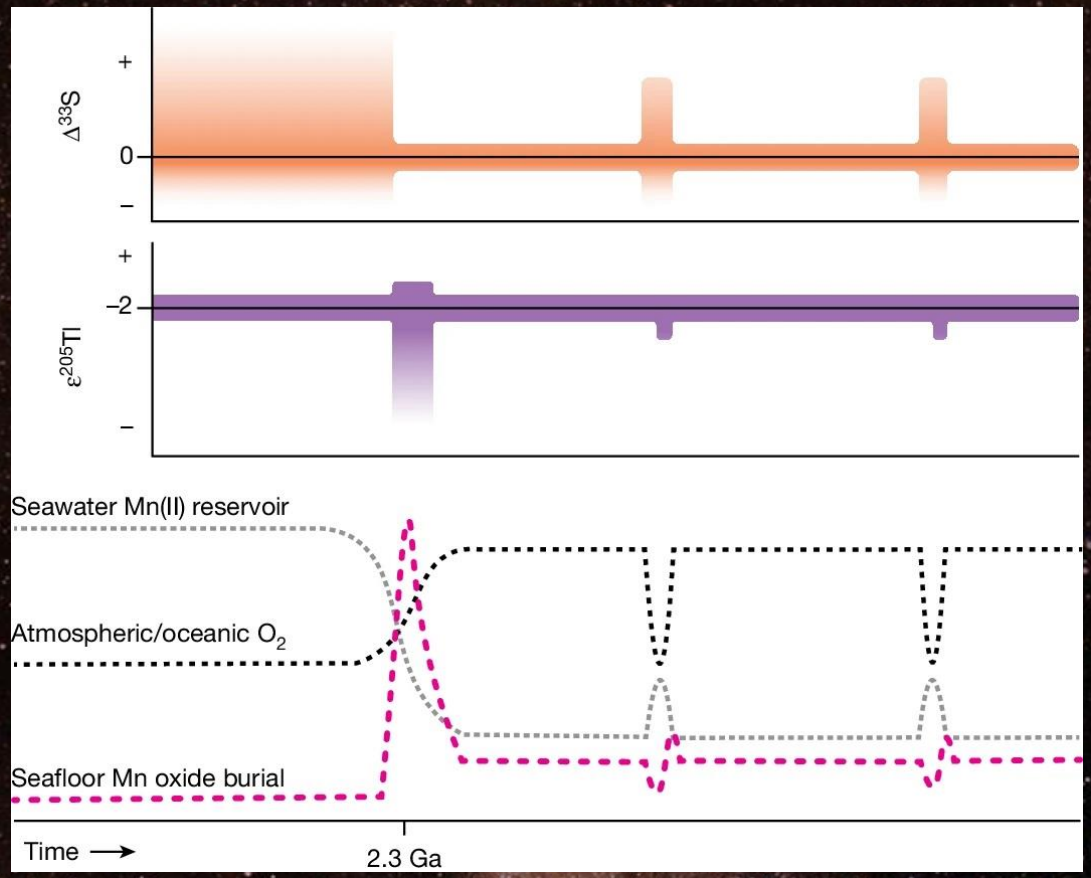



Glein C.R. (2024) The geochemical potential for metabolic processes on the...exoplanet K2-18b. Astrophys. J. Lett. 964, L19.

# Astrobiology - Research Highlight
# PI: Chad Ostrander

## Onset of coupled atmosphere–ocean oxygenation 2.3 billion years ago

- Previous sulfur isotope research revealed that the rise of atmospheric oxygen was oscillatory, but marine oxygen dynamics were unknown.
- Ostrander et al., measured Thallim (Tl) isotopes from the Archean Transvaal Supergroup in South Africa.
- Found lower authigenic 205Tl/203Tl ratios indicative of widespread manganese oxide burial on an oxygenated seafloor and higher redox-sensitive element abundances consistent with expanded oxygenated waters synchronous with S isotope evidence of atmospheric oxygenation in the same shales




Ostrander, C.M., Heard, A.W., Shu, Y. *et al.* Onset of coupled atmosphere–ocean oxygenation 2.3 billion years ago. *Nature* 631, 335–339 (2024).

80NSSC22K1628

# Astrobiology Research Programs Selection Rates

**ROSES 2022**

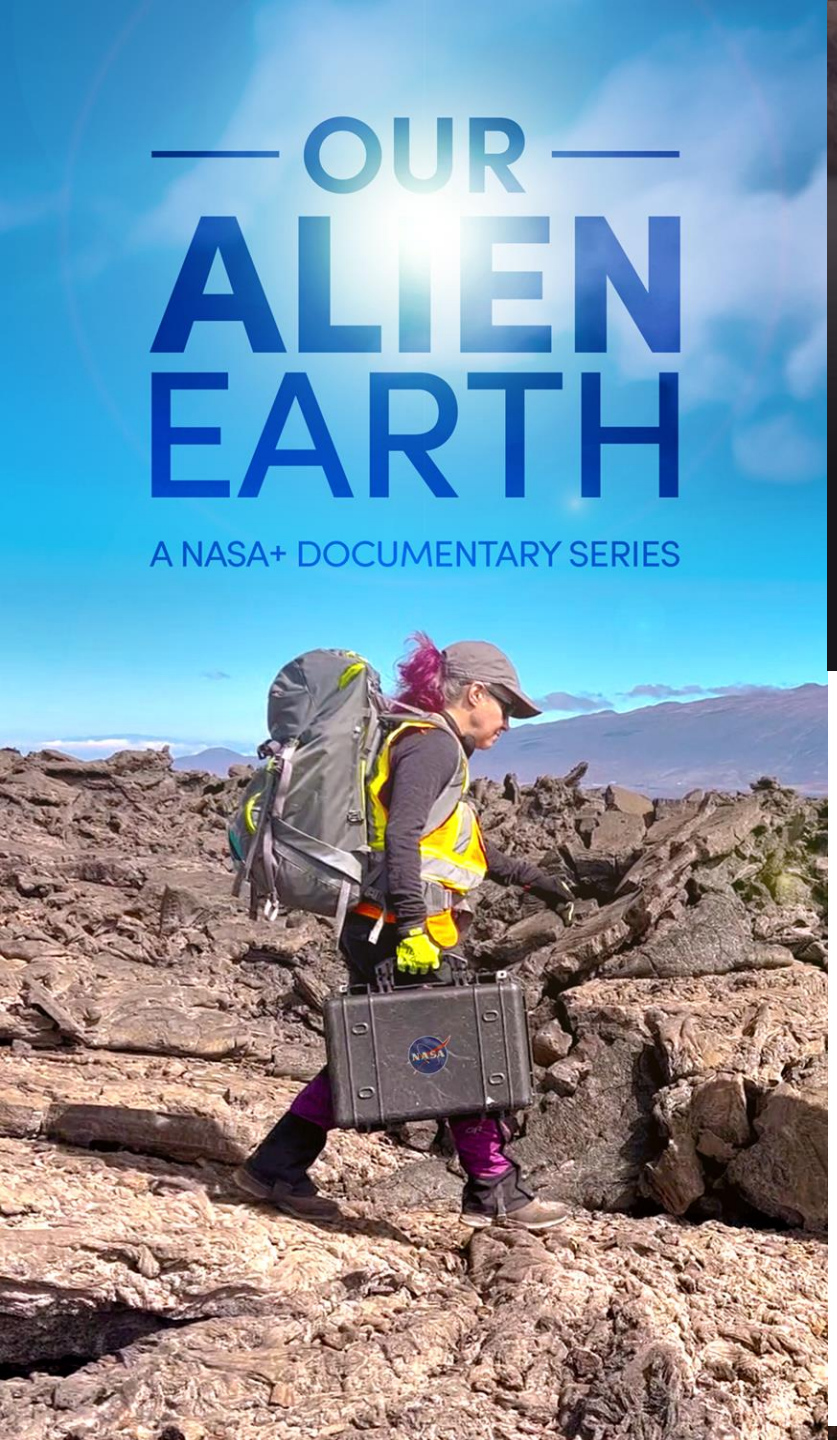
- Exo – 23%
- HW – 28%
- ICAR – 32%
- PSTAR – N/A
- XRP – 17%

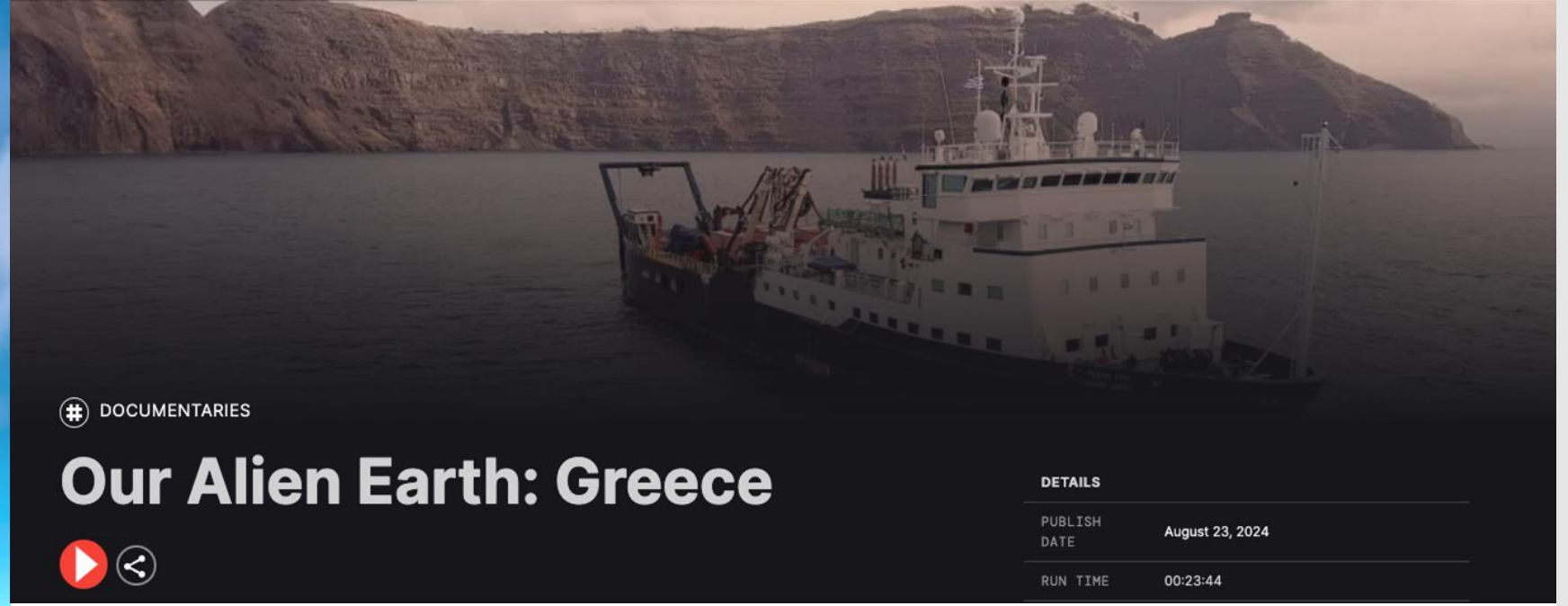
**ROSES 2023**

- Exo – 25%
- HW – 30%
- ICAR – N/A
- PSTAR – 20%
- XRP – 24%

**ROSES 2024**

- Exo – TBD
- HW – TBD
- ICAR – TBD
- PSTAR – N/A
- XRP – TBD




# Now Streaming on NASA+

Follow NASA scientists into the field as they explore the most extreme environments on Earth, testing technologies that directly inform NASA missions to detect and discover extraterrestrial life in the universe.

Episodes 1-3 are out now on NASA's new streaming platform, NASA+

1. The Lava Fields of Holuhraun, Iceland
2. The Ancient Isua Greenstone Belt, Greenland
3. The Undersea Volcanoes of Santorini, Greece

**NASA promoted Episode 3 from Aug. 27 - 30**

*The Undersea Volcanoes of Santorini, Greece*

Dive alongside Dr. Richard Camilli and his team as they explore the undersea volcanoes off of the coast of Santorini, Greece. Testing a suite of autonomous underwater vehicles, the team hopes to imbue their robotic explorers with the same scientific reasoning of a human astrobiologist, helping us characterize alien oceans and remotely search for signs of life on distant ocean worlds.

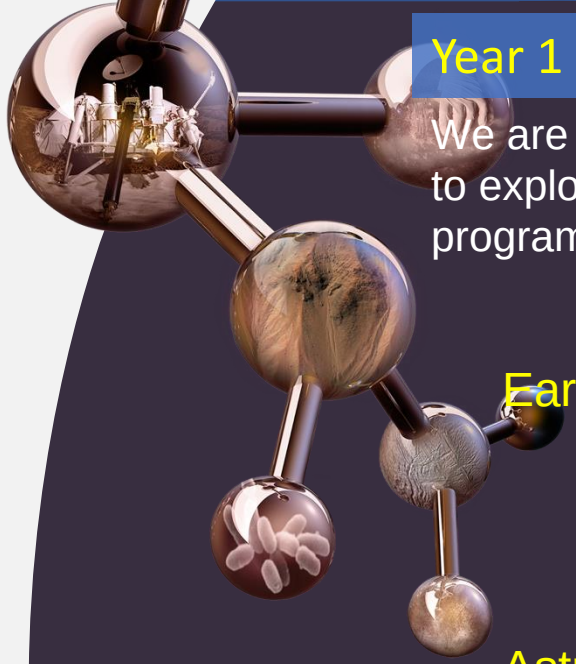
Watch the Trailer | Watch the Full Episode

# 2023-2024 Astrobiology Mission Ideation Factory


Search for Life at Mars

- Phase 1: NASA Goddard Space Flight Center, August 21-25, 2023
  - Contracted with KnowInnovation
  - 32 participants, U.S. and international, first year graduate student to early career faculty, at many institutions, cross-disciplinary
  - 6 mission ideas presented at end of week by teams of 3-7 individuals
  - 7 mentors from variety of backgrounds
- Phase 2: NASA Ames Research Center, November 12-15, 2024
  - TWSC grant to University of Washington, PI: Brook Nunn
  - Same participants invited
  - Work with mock data from mission ideas and make conclusions about whether life has been detected or not
  - Presents to jury of subject matter experts and general audience

Next Mission Ideation Factory Topic? HWO? Ocean Worlds? Other?



## Year 1 Goal: Increased cross-divisional & cross-directorate activity in Astrobiology at NASA.

We are in the process of planning and implementing several interdisciplinary community activities designed to explore and catalyze new interdivisional collaborations and the potential for possible new interdivisional programs.

### Earth Science:

Established Program to Stimulate Competitive Research (EPSCoR) on Ocean Worlds

Ocean Drilling Workshop (joint with NSF). April 2-4, Washington DC

### Astrophysics:

Supporting Habitable Worlds Observatory (HWO) working group on exoplanet biosignatures.

Joint communication efforts with Astrophysics on potential biosignature discoveries.

### Biological and Physical Sciences:

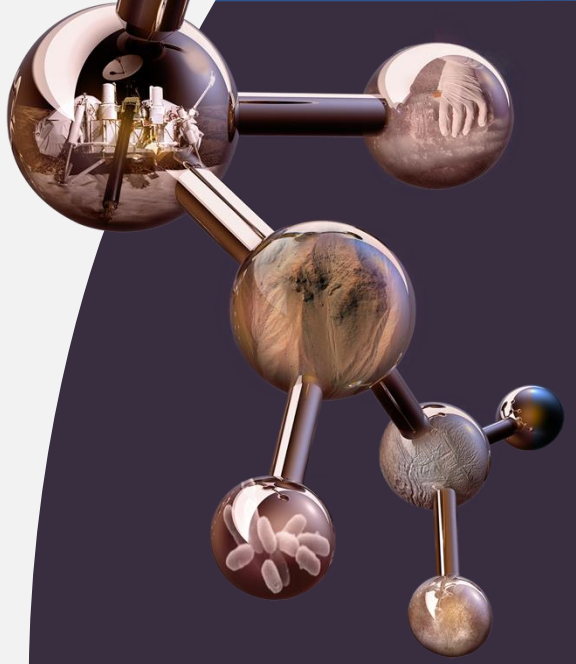
Workshop on Metagenomics, Planetary Protection and Astrobiology. Nov 19-22 at Ames.

### Cross-cutting interdivisional theme:

Future of Life.

### New Standing Committee for Astrobiology Coordination across SMD:

Astrobiology Federation.



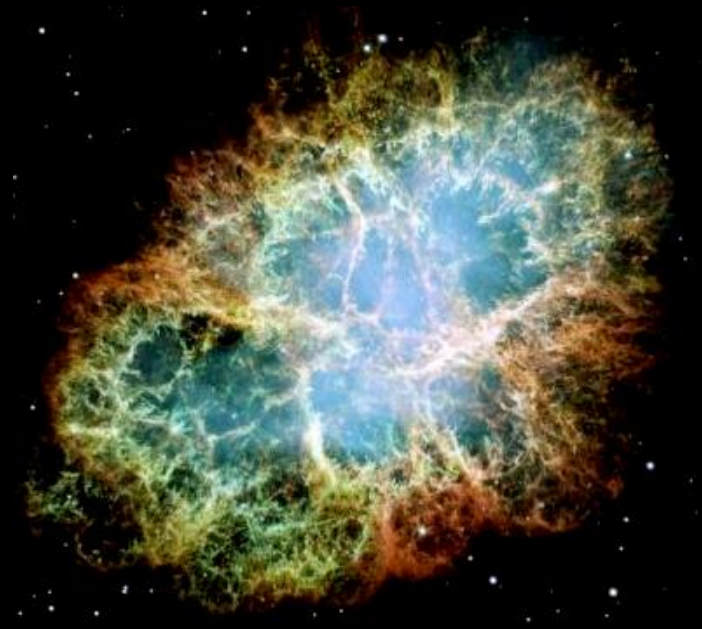
# Astrobiology Federation

Since D. Grinspoon started as Senior Scientist for Astrobiology Strategy in August 2023, he has been meeting with Program Scientists from all SMD science divisions on an ad hoc basis.

Idea is to regularize these contacts with an "Astrobiology Federation" with representation from all Divisions (and potentially other Directorates) to facilitate cross-Divisional collaboration and planning in topics relevant to Astrobiology.

Representatives suggested by Division Directors. To meet bi-monthly (starting Fall 2024) , and as needed.

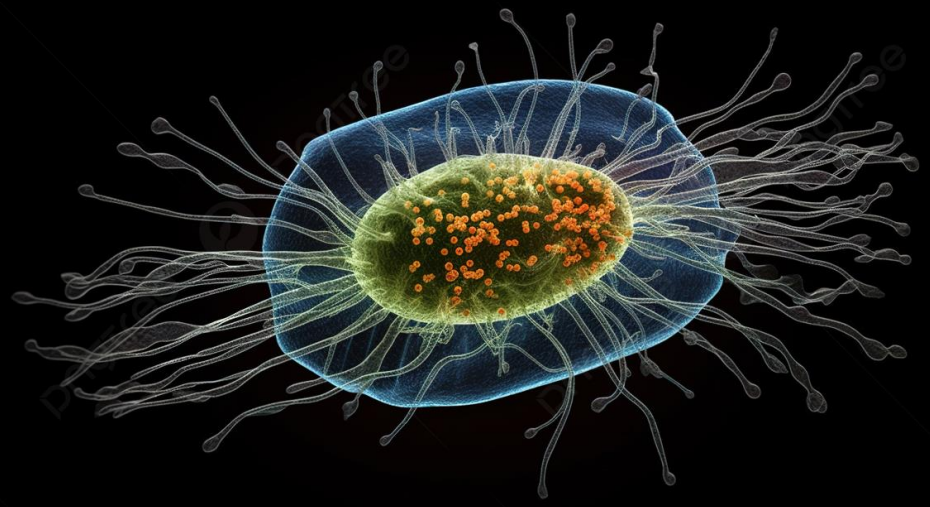
# Astrobiology addresses three fundamental questions



- How does life begin and evolve?

- Does life exist elsewhere in the universe?

- What is the future of life on Earth and beyond?



# Future of Life

- Technosignatures
- Future of Earth
- Sustainability (writ large)
- Deep time variability (& coevolution) of the Earth system
- Long term fates & states of biospheres & technospheres
- The future as exoplanet
- Becoming interplanetary
- Survival of Earth life on other planets
- Multigenerational life in isolated habitats
- Solar/stellar evolution and habitable zones
- Future habitability of outer solar system during sun's post-main sequence evolution.
- Future States and Fates of Ocean Worlds
- The sun's future path through the galaxy
- Long term stability of planetary systems
- How does life extend (or limit) habitable lifetimes?

# ASTROBIOLOGY
## and the
# FUTURE OF LIFE

Lunar and Planetary Institute

October 16-18, 2024

Organizing Committee:

David Grinspoon
Ariel Anbar
Eve Berger
Kelsey Bisson
Sharmila Bhattacharya
Lynn Clary
Kennda Lynch
Madhulika Guhathakurta
Nick Siegler
Michael Way
Jason Wright

~140 registrants
(~50% virtual)

During talks and discussions, (and report writing) let's keep this question in mind:

**What opportunities exist for future interdisciplinary research in the area of Astrobiology and the Future of Life?**

Highlight new ideas or research possibilities organized around this theme.

# Day 1 Program

**Wednesday, October 16, 2024, 8:30 AM**
**LPI Auditorium**


## Opening Remarks and Logistics

| | | |
|---|---|---|
| **8:30 AM** | David Grinspoon | **Welcome from the NASA Senior Scientist for Astrobiology Strategy** |

## Earth's Anthropocene and Beyond (Chairs: David Grinspoon, Hikaru Furukawa)

| | | |
|---|---|---|
| **9:00 AM** | Williams M.* Zalasiewicz J. Turner S. Wallenhorst N. Head M. J. et al. | **Is the Technosphere Causing a State Shift to the Earth System in the Anthropocene?** [#2079] Transformative human impacts have in the past 70 years ended stable Holocene conditions, initiating the rapidly evolving Anthropocene. Ongoing change driven by explosive growth of the technosphere is causing a state shift in the Earth System. |
| **9:30 AM** | Degroot D.* | **The History of Climate and Humanity: Close Calls, Opportunities, and Implications** [#2034] This talk will identify periods in which the trajectory of our species may have been profoundly altered by climate change, and it will speculate on the implications for the emergence and development of intelligent life elsewhere in the universe. |
| **9:45 AM** | Way M. J.* Tsigaridis K. Sohl L. E. Duarte J. C. Davies H. S. et al. | **What Might the End Permian Tell Us about Earth's Deep Future Climate** [#2042] We have explored Earth's climate +/- 250 Myr from the present day when the Earth is in a supercontinent state. The End Permian (250Ma) may inform Earth's habitability in the distant future (+250Myr) as both are more habitable than present-day Earth. |
| **10:00 AM** | | **Break and View Posters** |
| **10:45 AM** | Frank A.* | **The Short and the Long of It: From the Astrobiology of the Anthropocene to the Billion-Year Civilization** [#2094] In this talk I will discuss the Astrobiology of the Anthropocene and the problem of the Billion Year Civilization (BYC). |
| **11:15 AM** | Zalasiewicz J.* Turner S. Waters C. N. Summerhayes C. P. Williams M. et al. | **The New Geology of the Anthropocene** [#2056] The Anthropocene represents a new state of the Earth System that, from the mid-20th century, has diverged from the long-held stability of the Holocene Epoch. It has produced a novel, highly distinctive stratigraphic record of global extent. |
| **11:30 AM** | Furukawa H. Anbar A.* | **The Evolutionary Significance of the Anthropocene: An Energy Perspective** |
| **11:45 AM** | | **Discussion** |
| **12:15 PM** | | **Lunch** |

## Coevolution: Origins, Life, and Planets (Chairs: Eve Berger, Rakesh Mogul)

| | | |
|---|---|---|
| **1:45 PM** | Cabrol N. A.* | **Astrobiology as a Mirror: Coevolution, Earth's Future and Our Place on It** [#2058] The search for life in the universe is a powerful mirror reflecting information on the habitability of planets, environmental thresholds, and tipping points for distant worlds that we can compare to Earth. |
| **2:15 PM** | Sudakow I.* Vakulenko S. A. | **Planetary Climate Stability as a Catalyst for Critical Transitions in Biodiversity Evolution** [#2022] The study validates the Gaia hypothesis mathematically, showing biodiversity and functional diversity enhance biosphere-climate stability. Extended stable climates may cause extinctions with abrupt shifts. Planetary populations exhibit dynamics from periodic to chaotic. |
| **2:30 PM** | Bhattacharya D. B.* Stephens T. G. S. Van Etten J. V. E. McDermott T. M. | **Community-Wide Interactions Sustain Life in Geothermal Spring Habitats** [#2005] Analysis of a red alga-dominated geothermal spring community in Yellowstone National Park demonstrates that biotic interactions are highly structured and the result of community-wide interactions. This may also have been case on the early Earth. |
| **2:45 PM** | Johnson B. W.* Mallik A. Brounce M. J. Stueken E. | **Quantifying N Recycling in Subduction Zones and the Potential Impact on Planetary Biospheres** [#2104] The availability of accessible N is likely key for life throughout the universe. Here, we model the influence of differential N recycling in subduction zones to assess this impact on habitability and theoretical biospheres. |
| **3:00 PM** | | **Discussion** |

# Day 2 Program

**Thursday, October 17, 2024, 8:30 AM**
**LPI Auditorium**

## Exoplanets and Technosignatures (Chairs: Megan Ansdell, Nick Siegler)

| | | |
|---|---|---|
| **8:30 AM** | Youngblood A.* Roberge A. Arney G. Domagal-Goldman S. Dworkin J. | **Toward the Habitable Worlds Observatory** [#2086] The Habitable Worlds Observatory is a future NASA Astrophysics flagship. Its goal is to search for habitable exoplanets around nearby stars and perform transformative astrophysics and Solar System remote sensing studies. |
| **9:00 AM** | Bagheri F.* Lopez R. E. Shahmoradi A. | **Infrared-Radio-Follow-up Observations for Detection of the Magnetic Radio Emission of Extra-Solar Planets: A New Window to Detect Exoplanets** [#2041] We explore a novel approach to detecting and studying exoplanets exclusively through their radio emissions resulting from magnetospheric processes. |
| **9:15 AM** | Angerhausen D.* LIFE Initiative | **LIFE Looks for Life: Large Interferometer for Exoplanets Mission Concept** [#2053] We will present the unique discovery space for a MIR mission for the detection of atmospheric biosignatures in exoplanets. We will discuss the international scope of the initiative and highlight synergies between LIFE and NASA's future HWO mission. |
| **9:30 AM** | Hinkston M. A.* Bradley A. S. | **Using Energy Budgets as a Constraint on Maximum Biosphere Size** [#2090] We propose a first-order habitability metric based upon the energetic requirements of life and planetary energy budgets. We use this metric to constrain the maximum size of a potential biosphere on 28 solar system bodies and 356 exoplanets. |
| **9:45 AM** | | **Break and Posters** |
| **10:30 AM** | David Kipping | **The Future of Earth in the Context of SETI** |
| **11:00 AM** | Scharf C.* | **Does Life's Externalization of Information Dictate Its Future?** [#2030] I'll discuss the implications of the concept of a dataome for life's future trajectories in the context of planetary and stellar evolution. |
| **11:15 AM** | Schmidt G. A.* Kirtland Turner S. | **Back to the Future: The Technosignatures of the Anthropocene** [#2082] We use an intermediate climate model, including the carbon cycle, ocean sedimentation processes, and rock weathering to forward model the impact of Anthropogene on the marine sedimentary record to compare its technosignature with past events. |
| **11:30 AM** | Sheikh S. Z.* | **Technosignatures and the Future of Life** [#2046] An overview of the state of technosignatures research and how technosignatures relate to the future of life. |
| **12:00 PM** | | **Discussion** |

## Space Astrobiology (Chairs: Sharmila Bhattacharya, Eve Berger)

| | | |
|---|---|---|
| **2:00 PM** | Carr C. E.* | **Seeking and Supporting Life Beyond Earth: Stories of Community, Selection, and Evolution** [#2098] Astrobiology and space biology share common themes related to the power of community, and the measurement of selection and evolution. Such commonalities can help humans become interplanetary and seek life on Mars or beyond. |
| **2:30 PM** | Cassilly C. D.* Chander A. M. Bahr C. W. Vaughn J. A. Bertone P. F. et al. | **Cleanroom Microbes Survive Drying, Vacuum, and Proton Irradiation** [#2019] Microbes isolated from cleanrooms exist in low-nutrient, frequently cleaned environments and may exhibit extremophilic behavior. We identified four cleanroom isolates that demonstrated marked survival when exposed to simulated space-like stressors. |
| **2:45 PM** | Muratani M.* Sadier A. Rudolf A. | **Implications of Space Phenotypes and Multigenerational Effects of Terrestrial Organisms for Future Prediction of Life on Earth and Beyond** [#2075] How the concepts in evolutionary biology on Earth can contribute to astrobiology and prediction of future of life is discussed based on the intergenerational effects found in mouse spaceflight experiments. |
| **3:00 PM** | | **Break and Posters** |
| **3:45 PM** | Smith D. J.* | **Biology Ignores Mail Codes: Explaining Organizational Structures at NASA to Help Blast through Barriers for Interdisciplinary Astrobiology Research** [#2018] To achieve cross-disciplinary research goals, the astrobiology community must first understand where bioscience programs currently exist at NASA, an Agency which has distributed biological portfolios. |
| **4:00 PM** | Harris R. L.* Hays L. E. Grinspoon D. NASA Astrobiology Program | **NASA-DARES 2025: The NASA Astrobiology Strategy for Decadal Advances in Research, Exploration, and Synthesis** [#2109] This presentation from the NASA Astrobiology Program outlines the structure, scope, and goals of the forthcoming 2025 NASA Astrobiology Strategy for Decadal Advancements in Research, Exploration, and Synthesis (NASA-DARES 2025). |
| **4:30 PM** | Bell P. J. L.* Paras F. E. Mandarakas S. Arcenal P. Robinson-Cast S. et al. | **Growing Food without Light: A Swiss Army Knife-Style Yeast and the Future of Space Exploration** [#2074] Saccharomyces cerevisiae is a highly versatile yeast with significant potential in space exploration. We have extended the range of substrates it can utilize and developed an Electro-Microbial Process for Sustainable Food Production in Space. |
| **4:45 PM** | | **Discussion** |

# Day 3 Program

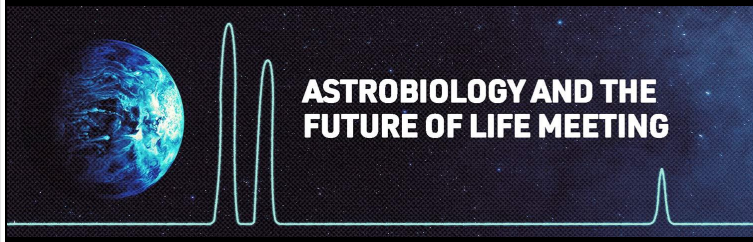
**Friday, October 18, 2024, 8:30 AM**
**LPI Auditorium**

Birth and Death: Solar, Stellar, Ocean Worlds, Evolution, and Habitability (Chairs: Laura Rodriguez, Julie Castillo-Rogez)

| | | |
|---|---|---|
| **8:30 AM** | Rakesh Mogul | **Venus as a Possible End Point to Earth Habitability** |
| **9:00 AM** | Opher M.* | **The Sun's Trajectory in the Last 10 Million Years and Possible Terrestrial Implications on Climate and Biological Evolution** [#2040]<br>This work discusses research indicating the encounter of Earth with massive cold clouds 3 and 7 million years ago. Both encounters shrank the heliosphere—exposing Earth to a cold, dense interstellar medium with implications for Earth's climate and bio-diversity. |
| **9:30 AM** | Airapetian V. S.* Chen H. Gronoff G. Hu J. Garcia-Sage K. | **Impact of Extreme Space Weather Events from the Sun on Earth in the near Future** [#2115]<br>Here we apply a global magnetospheric code, BATSRUS and a global atmosphere code, WACCM to study the response and recovery states of the magnetosphere, ionosphere-thermosphere-mesosphere system and lower atmosphere that has a critical impact to cli-mate of the future Earth. |
| **9:45 AM** | Vidotto A. A.* | **Exoplanetary Magnetism: Strengths, Magnetospheric Evolution, and Atmospheric Retention** [#2072]<br>I discuss 3 questions about exoplanetary magnetism: 1) What is the strength of exoplanetary magnetic fields? 2) How do magnetospheres of potentially habitable planets evolve? 3) What is the effectiveness of magnetism for atmospheric retention? |
| **10:15 AM** | | **Break and Posters** |
| **11:00 AM** | Vance S. D.* Journaux B. Castillo-Rogez J. C. Jones U. Melwani Daswani M. | **Hot and Cold Futures for Large Ocean Worlds** [#2080]<br>HOT: We consider what temperate conditions might occur in ice-covered ocean worlds as their host stars enter the red giant phase and the possibility of energetic buoyant overturning of high-pressure ices as oceans enter their endgame of freezing. |
| **11:30 AM** | Sparrman V. J.* Bladh S. Way M. J. | **Multiple Habitable Phases on Outer Exosolar Worlds** [#2016]<br>As stars evolve to higher luminosities, distant frozen worlds will thaw and enter the habitable zone. We measure how outer worlds' time spent inside the habitable zone depends on stellar distance in order to evaluate them as candidates for life. |
| **11:45 AM** | Castillo-Rogez J. C.* Melwani Daswani M. Weber J. M. Courville S. W. Meech K. J. et al. | **Life and Death of Small Ocean Worlds, the Most Frequent Ocean Worlds in the Solar System, and Likely in the Known Universe** [#2070]<br>Dwarf planets and most icy moons have limited heat sources. In our solar system, these bodies are frozen or on the edge of freezing. In other solar systems, these bodies could thrive as long-lived ocean worlds. |
| **12:00 PM** | | **Discussion** |
| **12:30 PM** | | **Lunch** |

Future Exploration and Further Cultural Dimensions (Chairs: David Grinspoon, Michael Way)

| | | |
|---|---|---|
| **2:00 PM** | Berea A.* Blanco C. Haqq-Misra J. Som S. Profitiliotis G. et al. | **Space Settlement and Astrobiology** [#2047]<br>In this paper we outline the connections and overlaps between astrobiology and space settlement as fields of study. |
| **2:30 PM** | Billings L.* | **Do Humans Have a Right to a Future Beyond Earth?** [#2015]<br>What Earth life deserves a future in the universe? Does human life deserve a future in the universe? What about other species on Earth? We humans tend to think that we are special. But are we? |
| **2:45 PM** | Wordsworth R.* Cherubim C. Nangle S. Berliner A. Dyson E. et al. | **Applied Astrobiology: Toward an Ecological Future in Space** [#2028]<br>Applied astrobiology has immense potential to advance life support technology and increase sustainability in space. In turn, development of ecosystems beyond Earth will broaden our understanding of life itself. |
| **3:00 PM** | Solomon S. E.* | **Becoming Martian: How Evolutionary Biology and Island Biogeography Can Inform Biological Change in Human Space Settlements** [#2031]<br>The rules of evolution apply to all species. People in space settlements would experience mutation, natural and sexual selection, genetic drift and gene flow. Founder effects and high mutation rates could drive rapid change and eventually speciation. |
| **3:15 PM** | | **Break and Posters** |
| **4:00 PM** | McCauley Rench R.* Gronstal A. | **Defining a Strategic Pathway from Limited Direct Observation of Exoplanets to Close-Approach Encounters for the Advancement of Astrobiology** [#2099]<br>Discuss the potential for a strategic pathway to return data from an exoplanet fly-by mission in the next 100 years, including an overview of the current technologies and the necessary advancements needed to support such a pathway. |
| **4:15 PM** | Denning K. E.* | **Astrobiology, the Future/s of Life, and the Future/s of Scientists** [#2105]<br>In contemplating the future of life we might find beyond Earth, we should also contemplate our own role/s in that future. We should, as human beings and as scientists, consider our potential impact upon other life, and its potential impact upon us. |
| **4:30 PM** | | **Discussion** |



National Aeronautics and Space Administration

# NASA-DARES:

## *The NASA Decadal Astrobiology Research and Exploration Strategy*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Astrobiology Program, NASA Headquarters

**David Grinspoon, Ph.D.**
Senior Scientist for Astrobiology Strategy
Astrobiology Program, NASA Headquarters

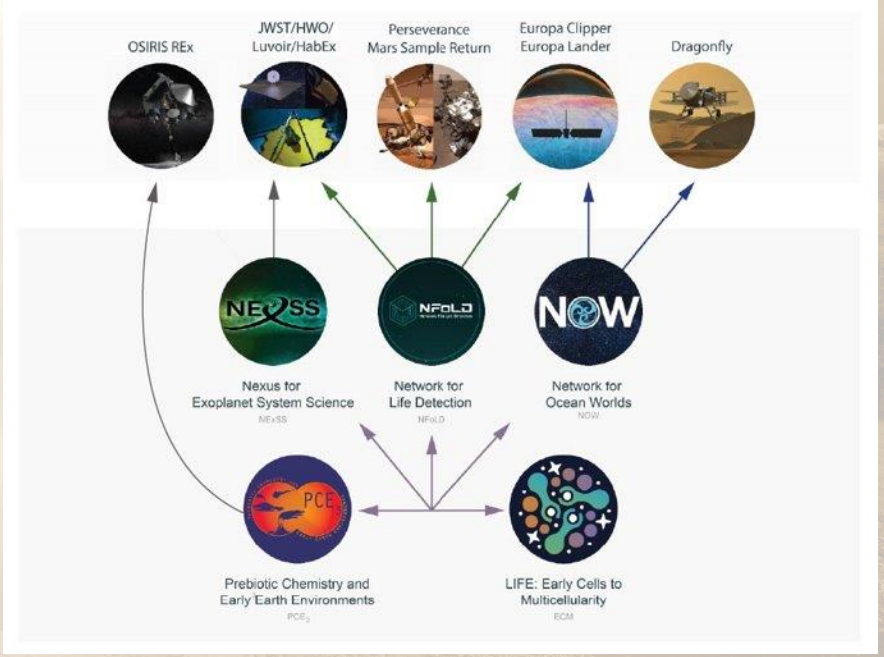
# Why a new Astrobiology Strategy now?


**Much has happened since the previous one.**

- New Decadal Survey in Planetary Science
- Research Coordination Networks (RCNs)
- Concrete evidence of habitable early environments on Mars and *intriguing rocks* have been sampled by Perseverance.
- Dragonfly confirmation.
- Magnesium sodium phosphates discovered in returned Bennu samples (OSIRIS-REx).
- Exoplanets (Trappist-1 discoveries, JWST results, planning for HWO).
- Tremendous progress in understanding biology and environmental evolution of early Earth.
- New technologies such as AI and networked small satellites.

**Worth looking more than 10 years ahead?**

- 20 years from now: Hopefully, samples back from many targets, HWO will be operating,
- Perhaps we'll be building a fleet of next generation telescopes.
- Perhaps we'll have found multiple biosignatures (or not).
- What laboratory & analytical techniques might we have access to?
- What will our science look like?



# Why do we need this on the heels of the Decadal?

**“Origins, Worlds and Life:** A Decadal Strategy for Planetary Science and Astrobiology 2023 – 2032" (OWL)

**OWL is a foundational document for NASA-DARES 2025.**

- The intent is to build off the priorities and recommendations identified within OWL.

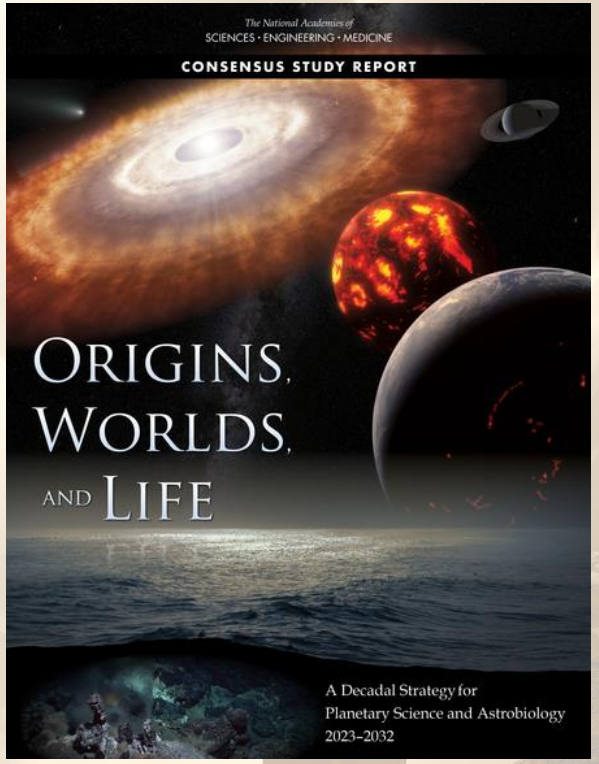
**OWL has a more specific, narrow focus than we intend for NASA-DARES 2025**

- OWL tied to Planetary Science and Exploration.
- OWL states explicitly that some areas of Astrobiology are not to be included:

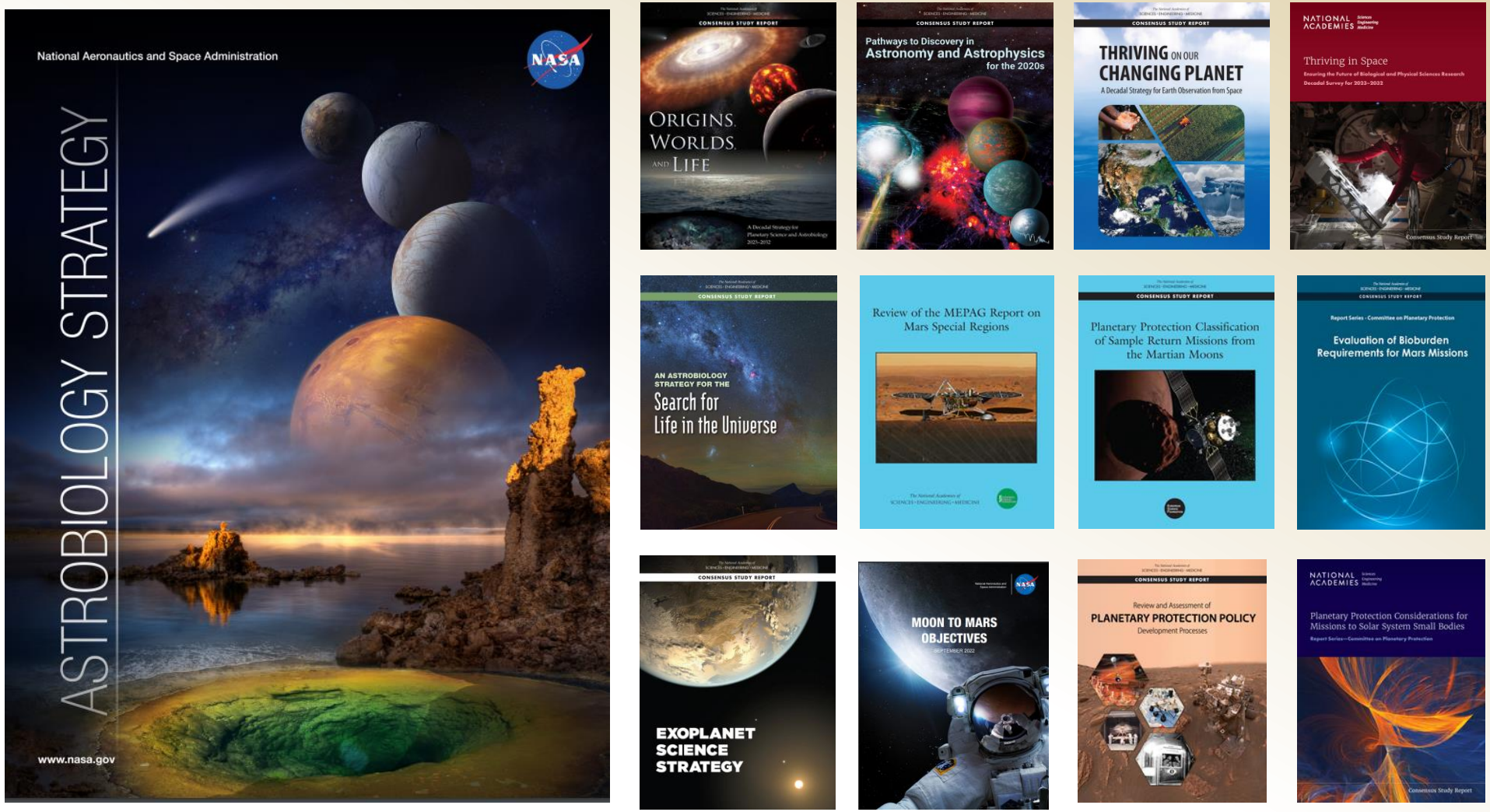
  *“Other aspects of astrobiology—such as synthesis and function of macromolecules in the origin of life and early life, and increasing complexity—are beyond the scope of this report.”*

**NASA-DARES 2025 will be more detailed and granular within astrobiology.**

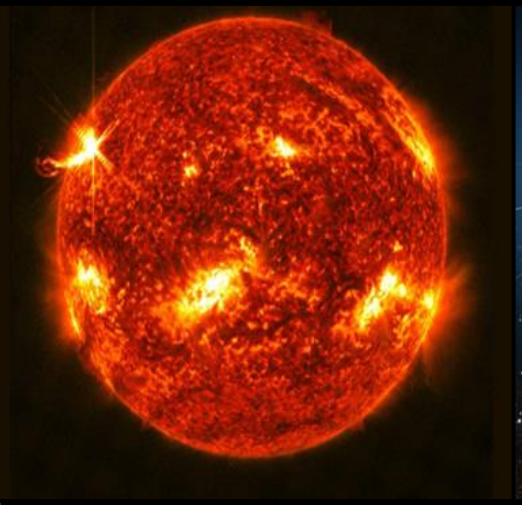
As Astrobiology is embedded within a wide-ranging document, OWL devotes much less space to the field than our previous Astrobiology Strategy. We will use the recommendations of OWL as scaffolding within which to fill in the details of a new, comprehensive, broad community-sourced Astrobiology Strategy.



# Astrobiology's programmatic relevance extends beyond PSD.



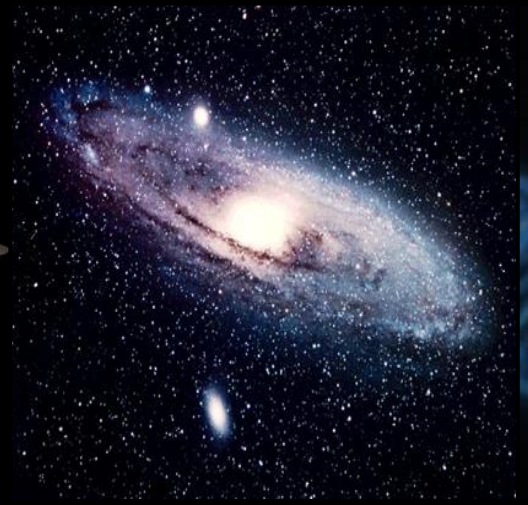
# NASA Science Divisions



Heliophysics

Earth Science

Planetary Science

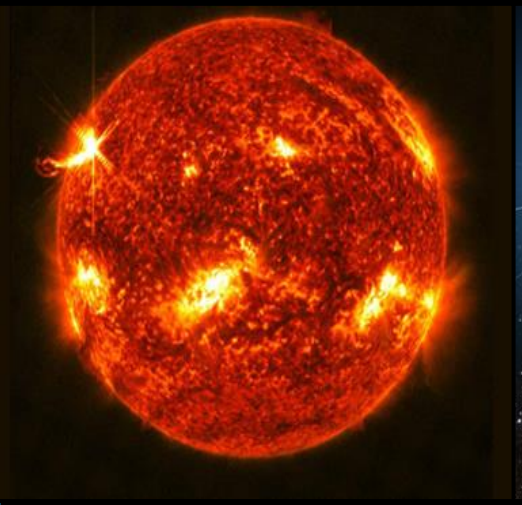


Astrophysics

Biological & Physical Science

Astrobiology

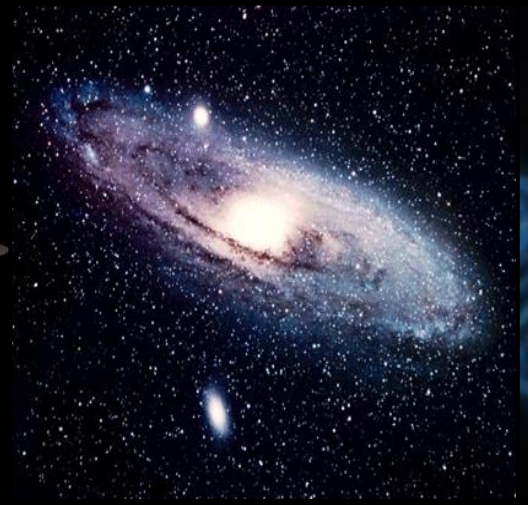
# NASA Science Divisions



Heliophysics

Earth Science

Planetary Science

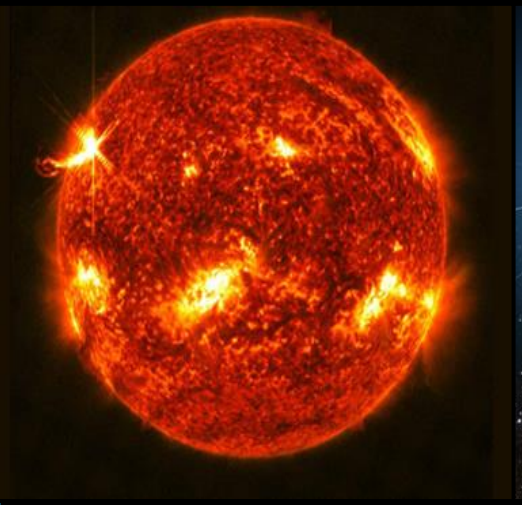


Astrophysics

Biological & Physical Science

**Astrobiology**

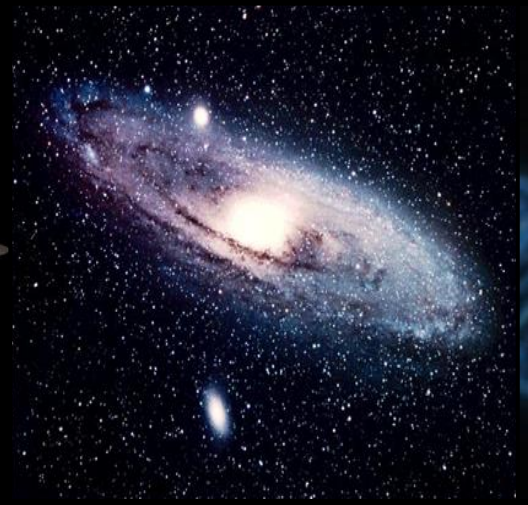
# NASA Science Divisions



Heliophysics

Earth Science

Planetary Science



Astrophysics

Biological & Physical Science

## "Astrobiology Federation"

ESSIO

OIIR

# Request for Information

# Development of NASA-DARES 2025:

## The NASA Decadal Astrobiology Research and Exploration Strategy

- NSPIRES Solicitation Number: NNH25ZDA002L
- 5 pages maximum including references
- 1 Primary Topic + up to 3 Secondary Topics per response
- No limit to the number of individual responses
- Response deadline: February 4, 2025 @ 11:59 PM ET

https://go.nasa.gov/ABStrategyRFI

Questions and comments about the RFI can be emailed to:

HQ-RFIastrobio@mail.nasa.gov

# Requested RFI Response Topics

| | |
|---|---|
| 1 | Review Recent Advancements |
| 2 | Identifying Emerging Themes & Technologies |
| 3 | Foster Cross-Divisional and Cross-Directorate Collaboration |
| 4 | Incorporate & Synthesize Recent Recommendations |
| 5 | Strengthen Community |
| 6 | Evaluate Astrobiology's Role in Missions |
| 7 | Astrobiology and Human Space Exploration |
| 8 | Prepare for the Discovery of Life Beyond Earth and Subsequent Post-Discovery Activities |
| 9 | Additional or Other Relevant Topic |

# This RFI is…

•An initial step in a **multi-phase** approach to shape NASA-DARES 2025.

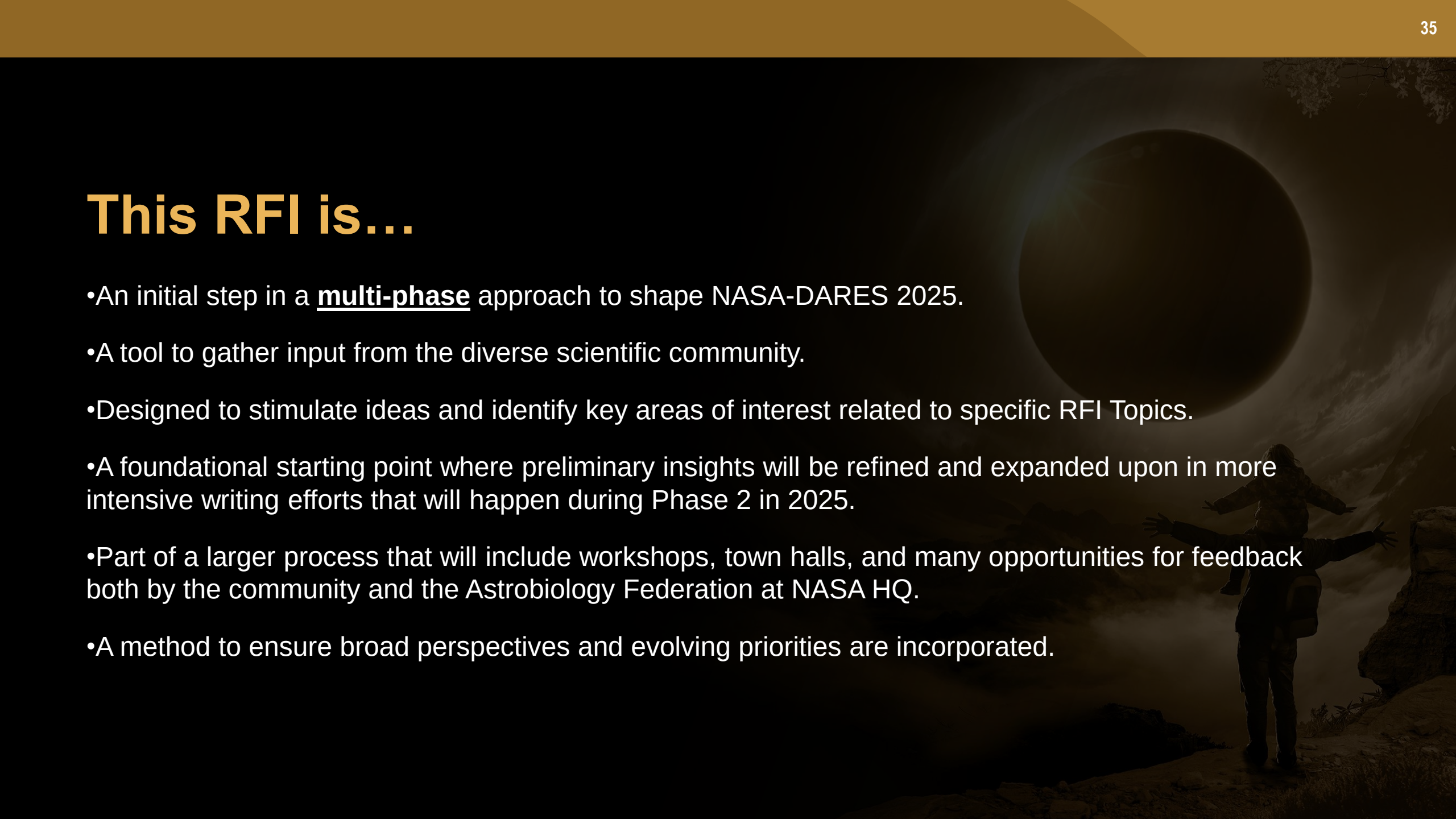
•A tool to gather input from the diverse scientific community.

•Designed to stimulate ideas and identify key areas of interest related to specific RFI Topics.

•A foundational starting point where preliminary insights will be refined and expanded upon in more intensive writing efforts that will happen during Phase 2 in 2025.

•Part of a larger process that will include workshops, town halls, and many opportunities for feedback both by the community and the Astrobiology Federation at NASA HQ.

•A method to ensure broad perspectives and evolving priorities are incorporated.



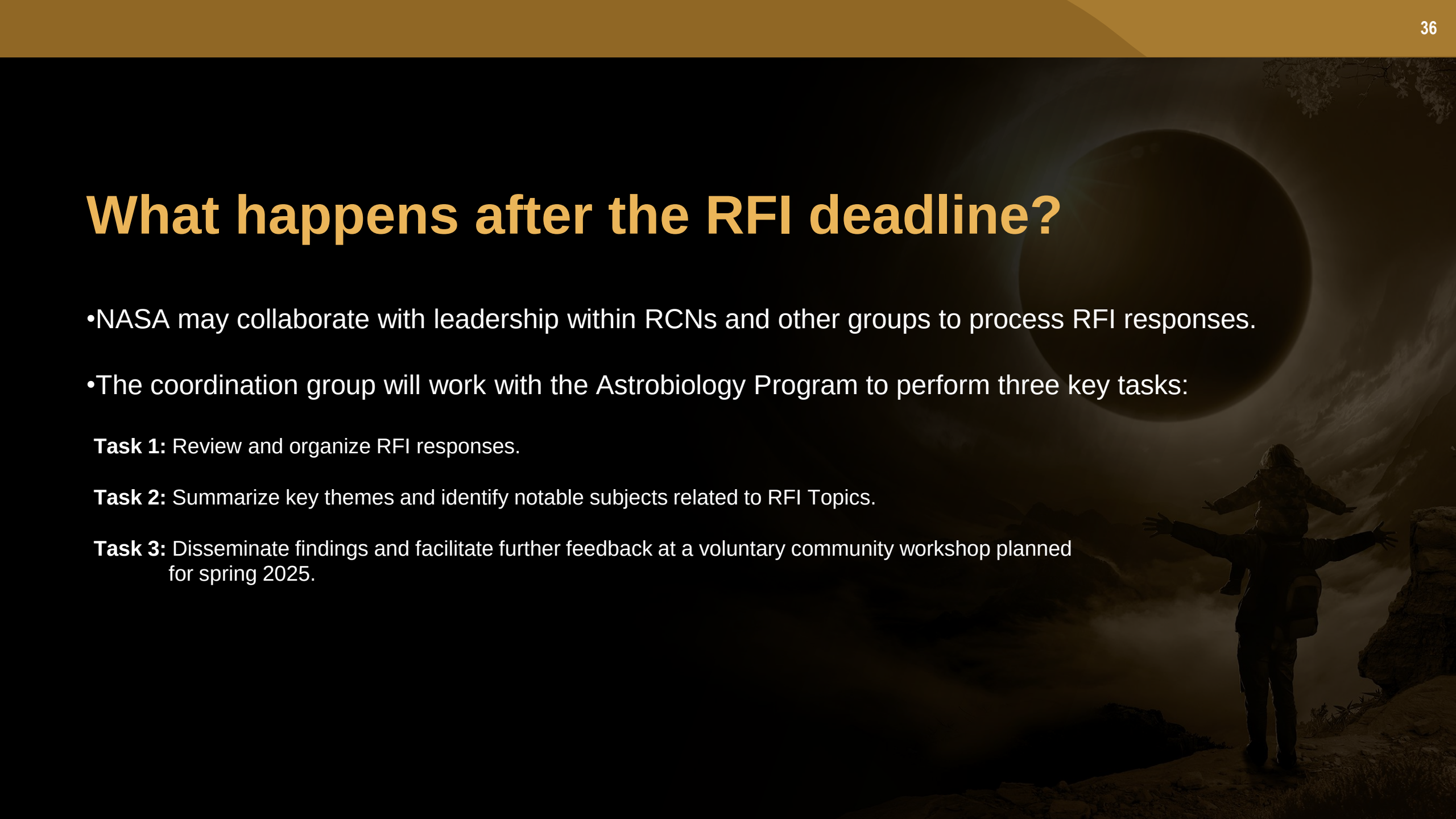
# What happens after the RFI deadline?

- NASA may collaborate with leadership within RCNs and other groups to process RFI responses.
- The coordination group will work with the Astrobiology Program to perform three key tasks:

**Task 1:** Review and organize RFI responses.

**Task 2:** Summarize key themes and identify notable subjects related to RFI Topics.

**Task 3:** Disseminate findings and facilitate further feedback at a voluntary community workshop planned for spring 2025.



# Questions?


Backup Slides

# Late 2024 – Early 2025

•Registration will open for NASA-DARES 2025 RFI Findings Workshop (Spring 2025)

•NASA will announce a call for nominations for a second coordination group (notionally “Task Force 2”) responsible for:

- Expanding and refining RFI findings into cohesive, detailed chapters for NASA-DARES 2025.
- Presenting draft findings for community input and feedback at topical workshops throughout 2025.
- Liaising with the Astrobiology Federation for critical review of key deliverables.

• Task Force 2 participants will be announced in Spring 2025.

- Participants will be on-boarded through the NASA Research and Education Support Services (NRESS).
- Non-civil servants will receive modest honoraria.

• Relevant announcements and documents will be shared via the Astrobiology mailing list (Sign up below!)

•https://lp.constantcontactpages.com/su/bu331jJ

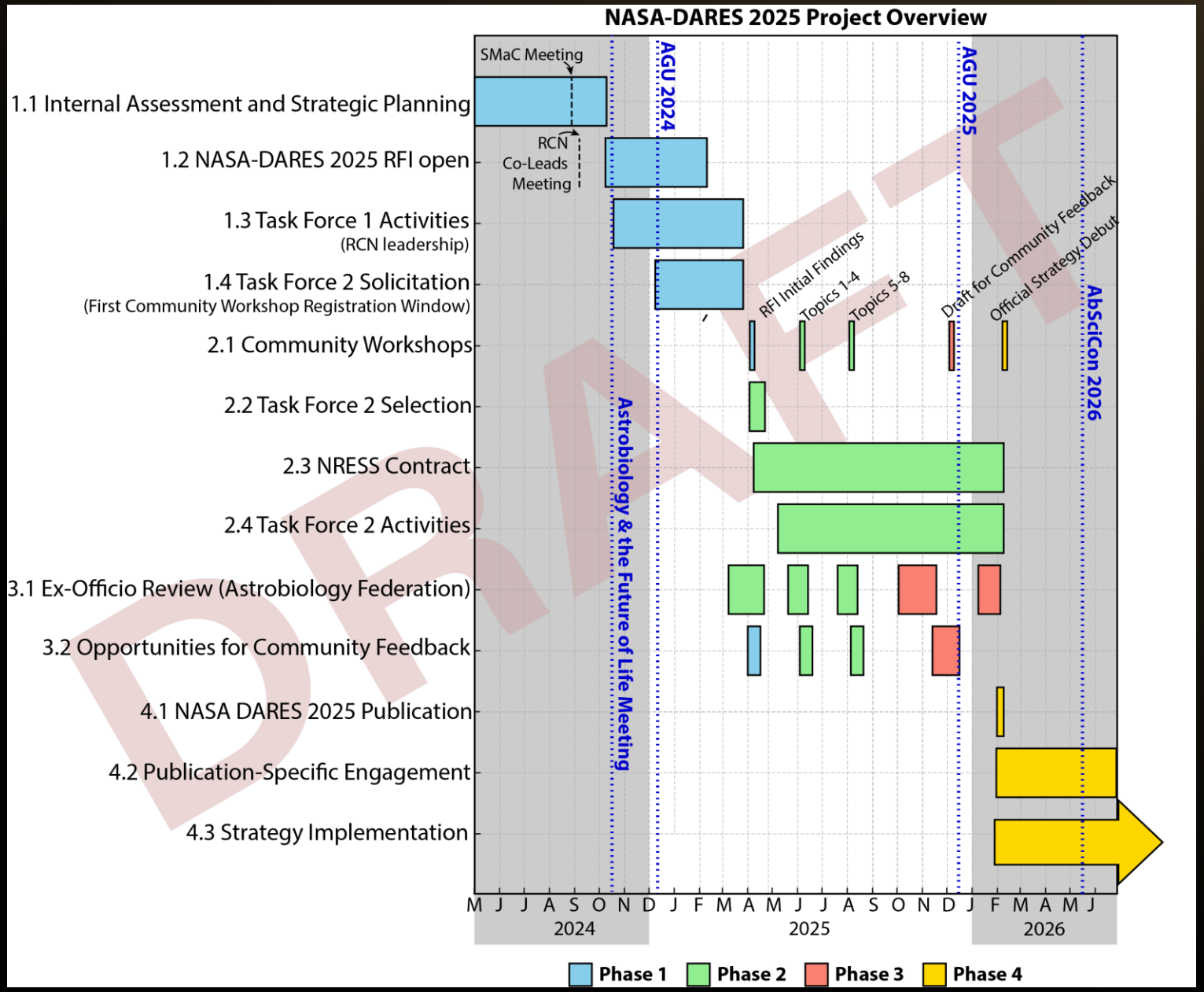
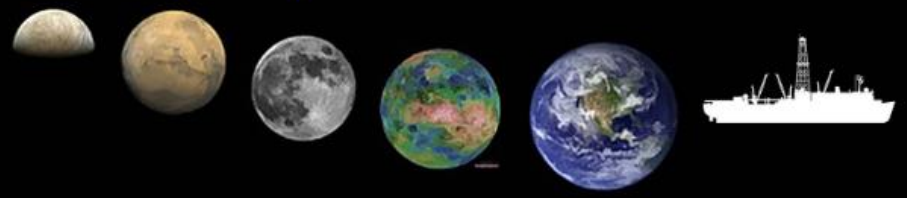



**Figure 1**. Proposed project timeline for the development of NASA-DARES 2025.

# INTEGRATING OCEAN DRILLING AND NASA SCIENCE

## A Workshop to Explore Missions to Planet Earth



**April 2–4, 2024**
**Washington, D.C.**

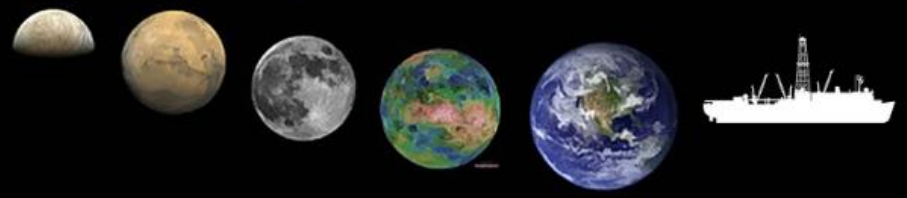
## Purpose and Scope

This is a strategic workshop that is designed to lay the foundation for a new partnership between the National Science Foundation (NSF) and NASA focused on scientific ocean drilling, which is aligned with the recent memorandum of understanding between the two federal agencies (Potter, 2021). The goal of this workshop is to identify and build on the scientific synergies that NASA's Earth and Planetary Science Divisions within the Science Mission Directorate (SMD) have with scientific ocean drilling and to explore using the United States scientific ocean drilling vessel and allied international drilling assets for joint research ventures.

This goal is in response to the 2050 Science Framework (2020) and the Explore Science 2020-2024: A Vision for Scientific Excellence (2020) (from NASA's Science Mission Directorate) documents. In both of these documents, collaborations with other agencies are welcomed and encouraged. Specifically, in the 2050 Science Framework (2020), connections and collaborations between scientific ocean drilling and space agencies are specifically highlighted as an Enabling Element (Terrestrial to Extraterrestrial) in the period 2024-2050. NASA's Science Mission Directorate has also highlighted "Interconnectivity and Partnerships" as one of its priorities for science in the period 2020–2024 (Science 2020–2024, pages 20–22). Five strategies are outlined to enable this, and strategies 3.2 (Actively seek collaborations with international partners based on their unique capabilities and mutual scientific goals) and 3.3 (Actively engage with other federal agencies to make more informed decisions, cooperate in scientific research, and pursue partnerships that further national interests) are particularly pertinent to forging linkages with scientific ocean drilling, which is international in nature.

INTEGRATING OCEAN DRILLING AND NASA SCIENCE

A Workshop to Explore Missions to Planet Earth



**April 2–4, 2024**
**Washington, D.C.**

| | Division | Research Emphasis | Ocean Drilling Research: 2050 Science Framework |
|---|---|---|---|
| NASA's Science Mission Directorate | Earth Science | Climate Variability and Change | FI: Ground Truthing Future Climate Change<br>SO: Earth's Climate System |
| | | Carbon Cycle and Ecosystems | SO: Global Cycles of Energy and Matter |
| | | Earth Surface and Interior (Geohazards) | FI: Probing the Deep Earth<br>FI: Assessing EQ and Tsunami Hazards<br>SO: Natural Hazards Affecting Society |
| | Planetary Science | Origin and Evolution of Life | FI: Exploring Life and its Origin<br>SO: Habitability and Life on Earth |
| | | Origin and Evolution of Planetary Bodies | FI: Probing the Deep Earth<br>EE: Terrestrial to Extraterrestrial |

# CDSLU: Communicating Discoveries in the Search for Life in the Universe

## Overview

If astrobiologists discover evidence of life beyond the Earth, how should these findings be shared with the public? Which communication strategies and techniques would best support public understanding of findings that are likely to be complex and highly specialized? Astrobiology faces a fundamental tension between the implications of finding evidence of biology or biological processes elsewhere in the universe, and explaining how observations or experiments used to accumulate that evidence will be subject to uncertainty and controversy. How might scientists and science communicators navigate this tension and communicate effectively about this uniquely compelling but challenging research?

This virtual workshop organized by NASA's Astrobiology Program (NAP) will bring together astrobiologists, science journalists, science communicators, and science content creators for a series of presentations, conversations, and activities aimed at building a greater shared understanding of the challenges and opportunities for each group that such an event might present. By creating a space to exchange perspectives, experiences, professional realities, and foster relationships between scientists and science communicators we hope to explore mutually-beneficial and socially responsible paths towards communicating the discovery of extraterrestrial life.

## Summary

This virtual workshop will bring together the astrobiology and science communication communities to exchange perspectives about the potential discovery of life beyond Earth. Through a series of presentations, conversations, and activities the workshop will explore mutually-beneficial and socially responsible paths towards communicating the discovery of extraterrestrial life and creating a lasting community of shared interest.

**Virtual Workshop Session Details**

**Kickoff webinar**: Friday February 23, 11am to 12 pm EST

**Day 1:** Friday March 1, 11 am to 1 pm EST

**Day 2:** Monday March 4, 11 am to 2 pm EST

**Day 3:** Wednesday March 6, 11 am to 3 pm EST