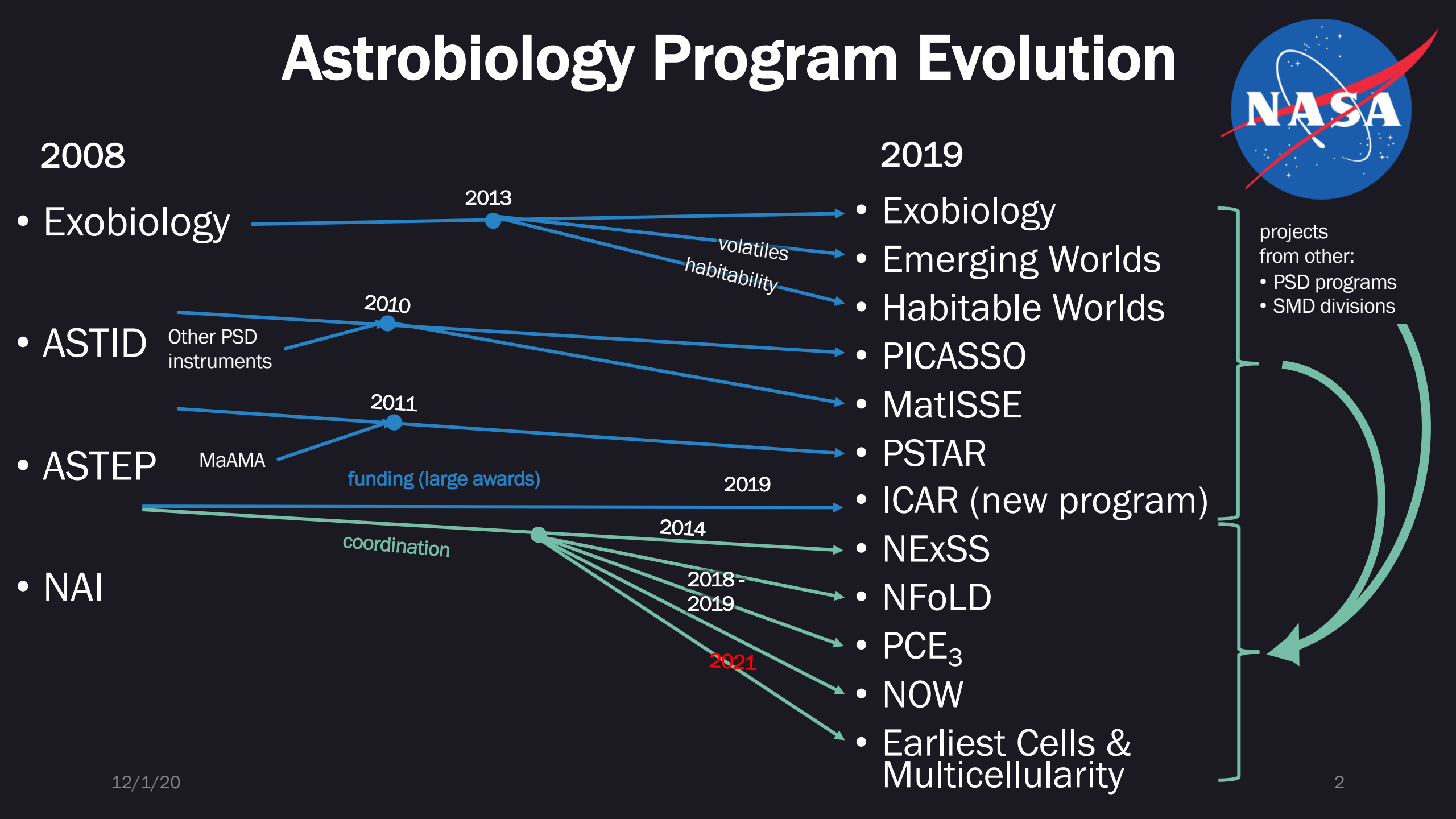
Update from NASA Astrobiology Program

Mary Voytek
Astrobiology Senior Scientist

PAC
November 30, 2020

Astrobiology Program Evolution

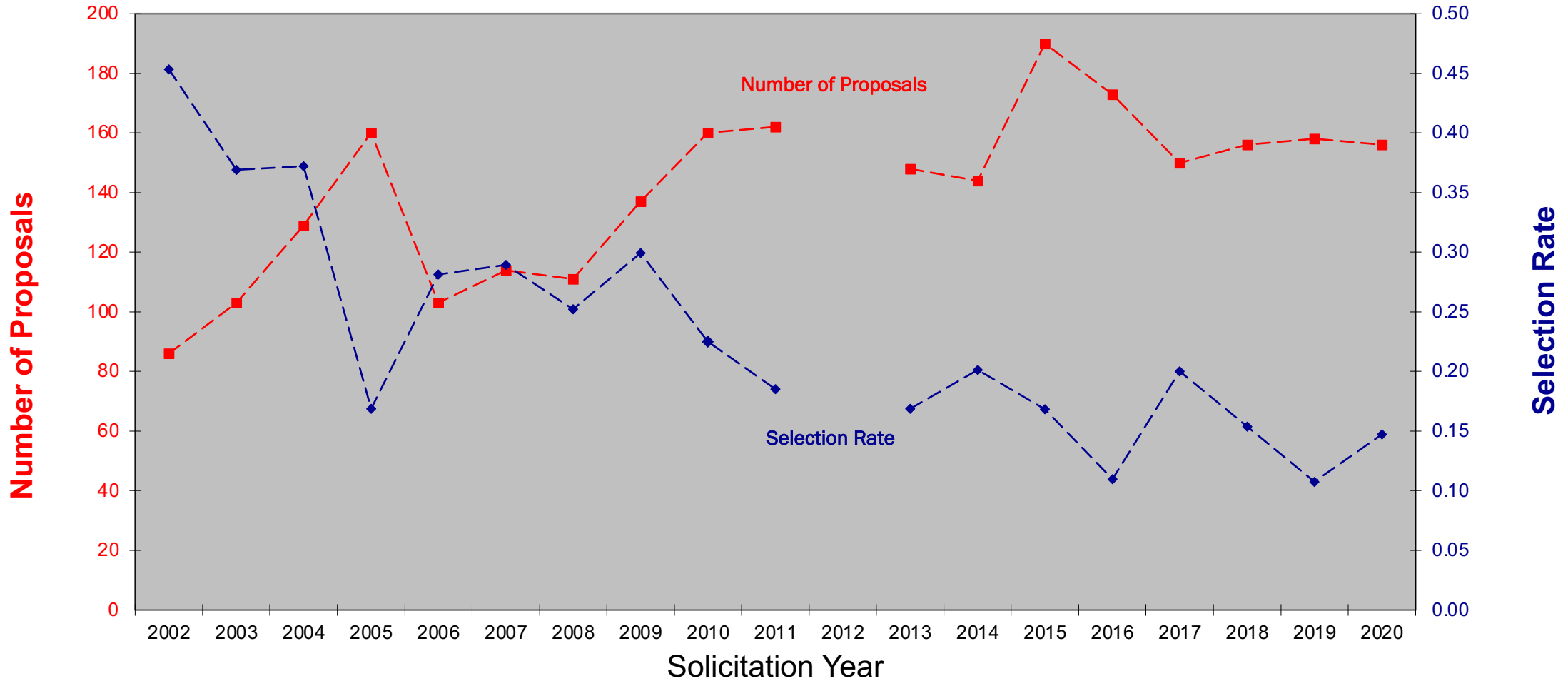


Exobiology – ROSES 20

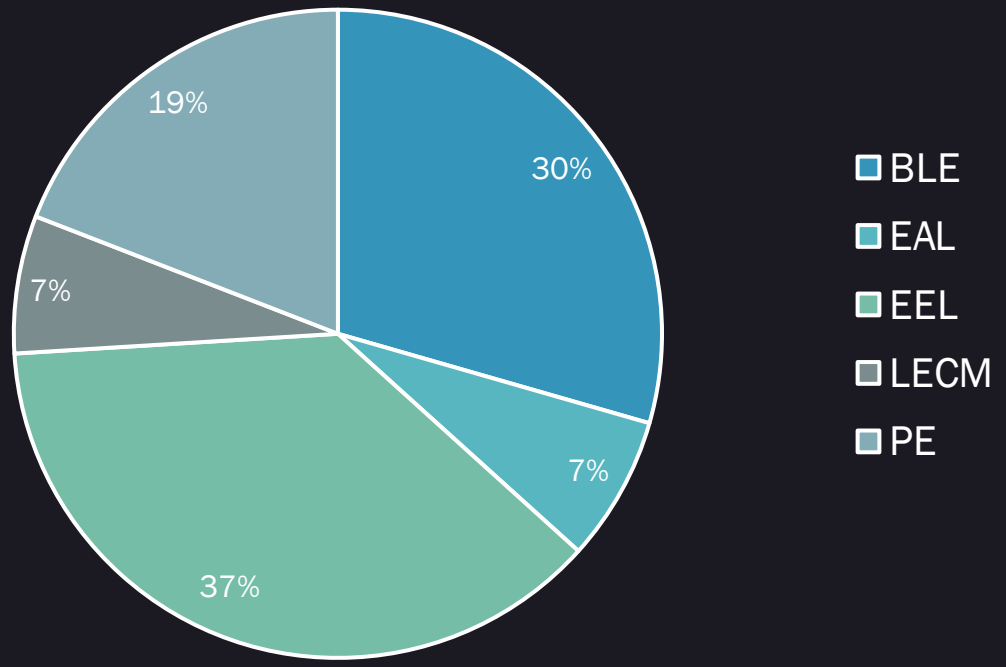
- ROSES-20 NOI due 4/22, full proposals due 5/22

- 156 Proposals submitted
  - 23 proposals were initially selected for funding
- Final Selection rate is 14.7%

History of Exobiology NRAs



Distribution of Funded Tasks - Exobiology



Percentages based on award amounts. Abbreviations are: BLE Biosignatures and Life Elsewhere; EAL Evolution of Advanced Life; EEL Early Evolution of Life and the Biosphere; LECM Large scale environmental change and Macro-evolution; PE Prebiotic Evolution.

- Program currently funds 8 FINESST students
- Program currently supports 2 Early Career Fellows who have received start-up funding

Habitable Worlds – ROSES 18/19

ROSES-18

60 Proposals submitted

- 10 proposals were selected for funding
- 9 fully selected
- 1 partially funded

Selection rate is **16.7%**

ROSES-19

65 Proposals submitted

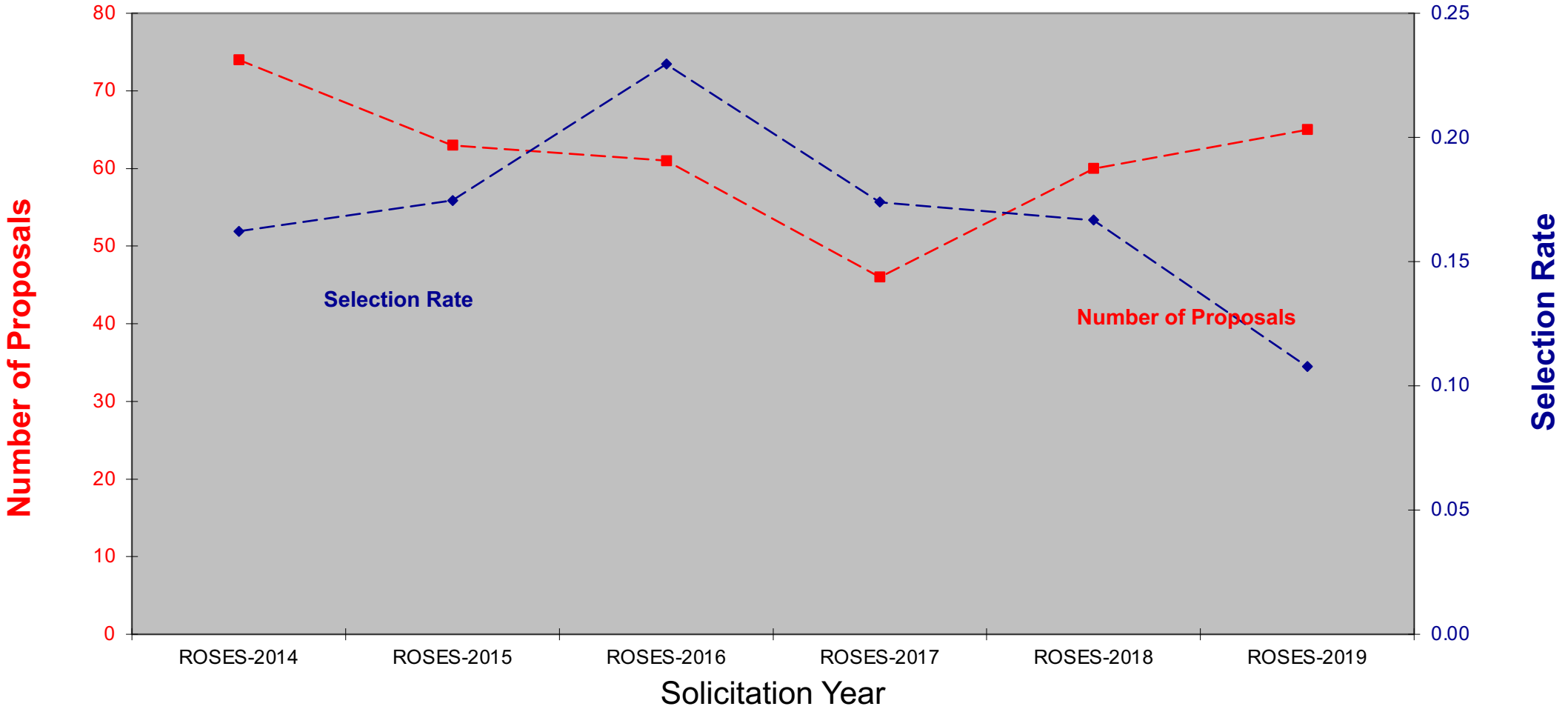
7 proposals were selected for funding

- 3 related to Mars Habitability
- 1 related to Icy/Ocean Worlds Habitability
- 3 related to Exoplanet Habitability

Selection rate is **11%**

ROSES-20- HW will be part of the Dual Anonymous process.

History of Habitable Worlds NRAs



Planetary Science and Technology through Analog Research (PSTAR) – ROSES 18/19

ROSES-19

Proposals Submitted: October 10, 2019

81 Step-1 Proposals submitted (24 discouraged)

48 Step-2 Proposals submitted

4 proposals were selected for funding

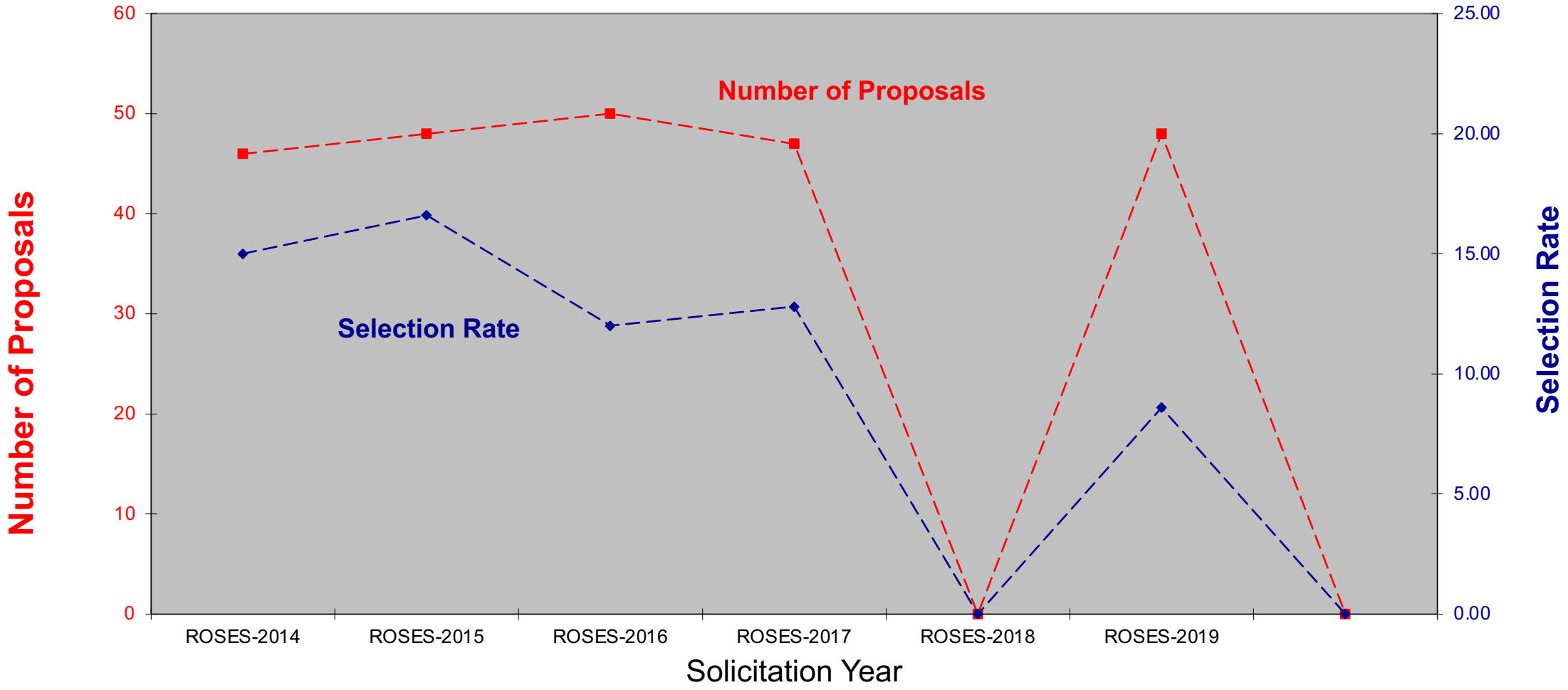
- 2 related to Mars exploration
- 1 related to Icy/Ocean Worlds exploration
- 1 related to Venus exploration
- Selection rate is **8.3%**

ROSES-20

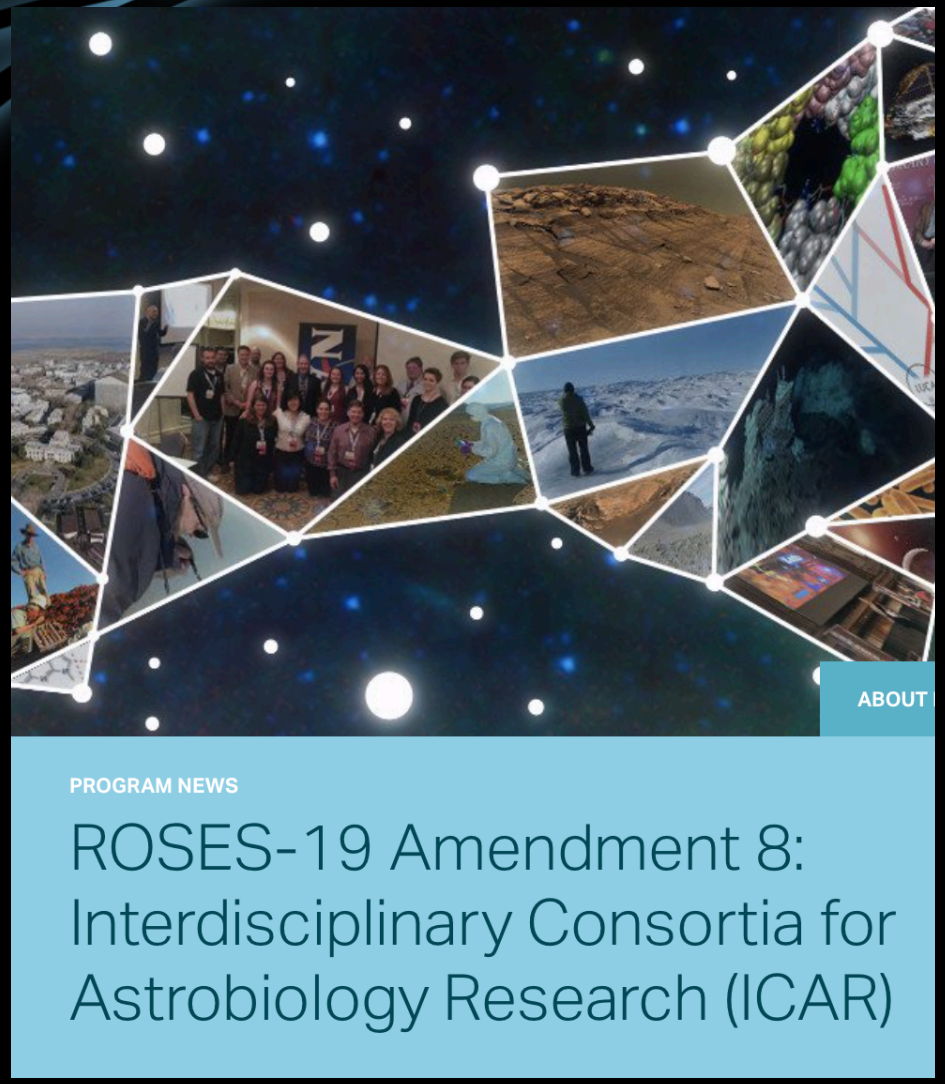
PSTAR will not be solicited, moving to a biennial solicitation cadence

Currently: 7 active grants, 1 active NESSF award.

History of PSTAR NRAs



Interdisciplinary Consortia for Astrobiology Research (ICAR)



Solicitation: NNH19ZDA001N-ICAR

ICAR 19– two-step

- Received 46 Step 1s
  - Encouraged 34
  - Discouraged 9
  - Declined 3 (out of scope)
- Received 30 Step 2s

Selected 8 teams (6- 15% Re,d 2- Descoped)

Awards will be made in Feb 2021

5 year awards

Avg award size $5M

Scope of Opportunity

. . . an opportunity for the submission of proposals that describe an interdisciplinary approach to a single, compelling question in astrobiology, and may address a single Science Strategy goal or several Science Strategy goals.

Team size and resources requested should be appropriate to the scale of the proposed research. There is no ideal size of an ICAR Team, but the scope of the research and the resources requested should exceed those typically considered in a ROSES program element (e.g., Exobiology, Habitable Worlds or XRP).

The research areas in this cycle include: prebiotic chemistry and early Earth environments, early life and increasing complexity, and the habitability and biosignatures on exoplanets. PIs selected as a result of proposals to this program element will become members of the newly established Astrobiology Program Research Coordination Networks that are relevant to their selected research.

Astrobiology Research Coordination Networks

NExSS
Nexus for Exoplanet System Science

PCMC
From Early (primitive) Cells to Multicellularity

N-FoLD
Network for Life Detection

PCE_3
Prebiotic Chemistry and Early Earth Environments

NOW
Network for Ocean Worlds

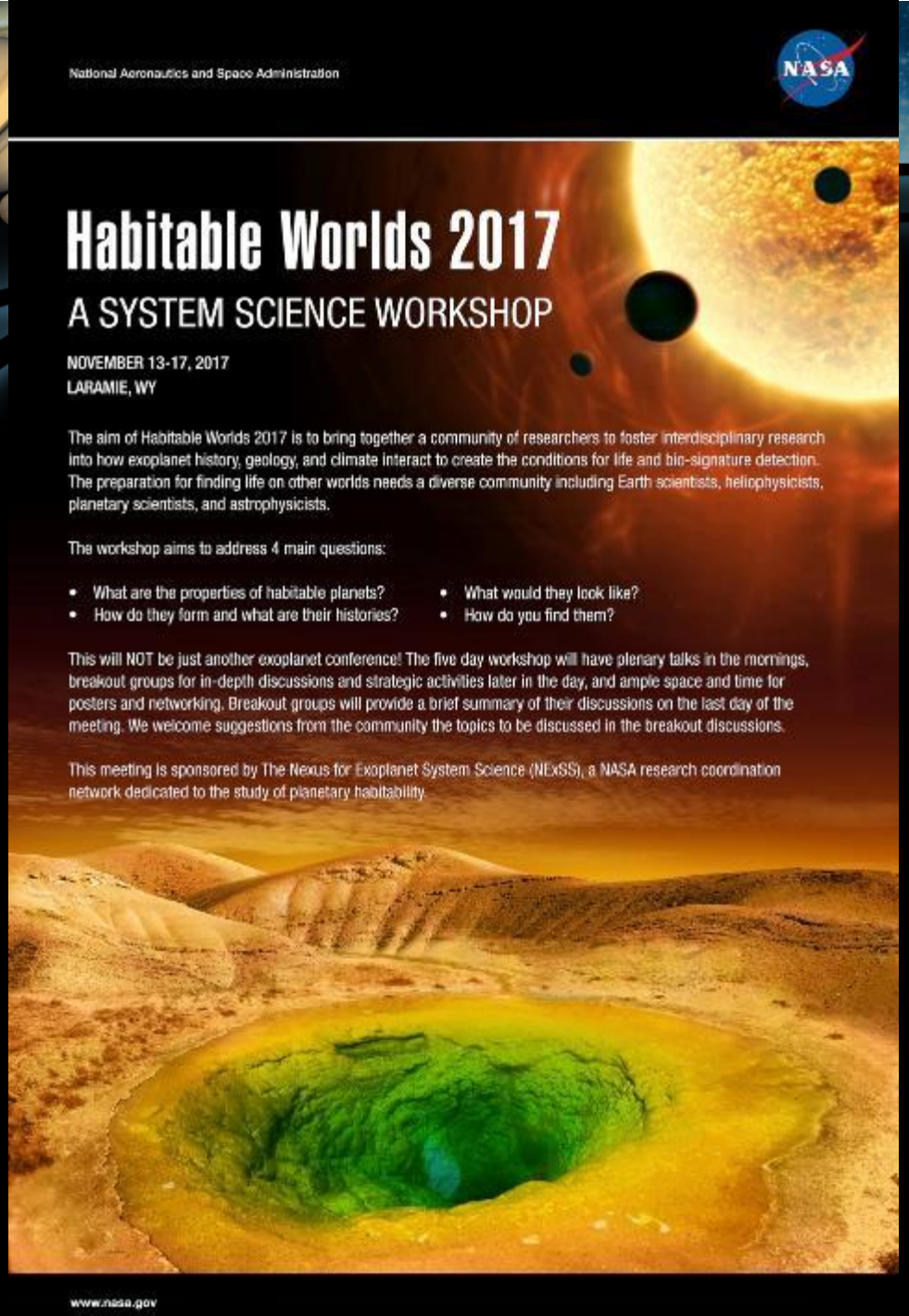
RCN	PI	Title	Institution
PCMC	Kacar, Betul	What life wants: Exploring the natural selection of elements	University of Arizona
PCMC	Walker, Sara	Planetary Systems Biochemistry	Arizona State University
PCE3	Lyons, Timothy	Alternative Earths – How to Build and Sustain a Detectable Biosphere	University of California, Riverside
PCE3	Seelig, Burckhard	Emergence of a complex biochemical system: Evolutionary aspects of the path to coded protein synthesis	University of Minnesota
PCE3	Burke, Donald	Bringing RNA to Life – Emergence of Biological Catalysis	University of Missouri
NExSS	Apai, Daniel	Alien Earths: Which Nearby Planetary Systems Are Likely to Host Habitable Planets and Life?	University of Arizona
NExSS	Stevenson, Kevin	The M-dwarf Opportunity: Characterizing Nearby M-dwarf Habitable Zone Planets	Johns Hopkins University
NExSS	Batalha, Natalie	Follow the Volatiles: Tracing chemical species relevant to habitability from proto-planetary disks to exoplanet atmospheres	University of California, Santa Cruz

Astrobiology Research Coordination Networks

<u>Co-Leads:</u>
Dawn Gelino
Vikki Meadows
Shawn Domagal Goldman
Daniel Apai

Steering Committee: V. Airapetian, D. Apai, S. Desch, J. Fortney, J. Graham, W. Henning, H. Jang-Condell, A. Jensen, W. Moore, N. Turner, J. Wright, D. Brain, S. Andrews, T. Brandt, D. Charbonneau, J. Christiansen, R. Dasgupta, R. Dawson, J. Davenport, C. Dong, N. Haghighipour, S. Kane, R. Kotulla, G. Rieker, T. Robinson, H. Schlichtin, S.-H. Shim, A. Shields, K. Stassun, A. Weinberger, C. Reinhardt, A. Mandell

PIs invited from SMD Programs: NAI ADAP, XRP, Habitable Worlds



NExSS Activities in the Works:

Workshops

- Exoplanets in our Backyard (Houston, Feb 2020, APD & PSD PAGs)
- Habitable Worlds 2 (Early 2021, joint w/AAS)
- 1D & 3D GCM Model Comparison Workshop (2021/22)
- Magnetic Field Affects on Habitability (2021/22)

Webinars

PSD Decadal Preparation

Science Working Groups

- Exoplanet/Solar System Synergies
- Interior/Atmosphere exchange
- Atmospheric Escape and Evolution

Communications Working Group

- Inter-team, Science Community, HQ
- Science Nuggets, Opportunities, Knowledge Exchange

More involvement from early career scientists

- NPP opportunity

New Slack Workspace – *anyone* can join our slack!

- New Working Group Channel
- New Early Career Channel

Connections Across RCNs

Astrobiology Research Coordination Networks

Co-Leads:
Karyn Rogers
Loren Williams
Ramanarayanan Krishnamurthy
Tim Lyons

Steering Committee: V. Airapetian, A. Badran, S. Benner, D. Bong, D. Burke, A. Burton, I. Chen, G. Cody, G. Cooper, R. Dasgupta, J. Elsila, P. Falkowski, G. Flynn, R. Garrod, M. Hirschmann, C. Keating, R. Black, R. Lupu, J. Lyons, U. Muller, M. Pasek, S. Sandford, R. Smith, G. Villanueva, D. Woon

Invited 33 PIs from Exobiology and Emerging Worlds programs

Astrobiology Research Coordination Networks

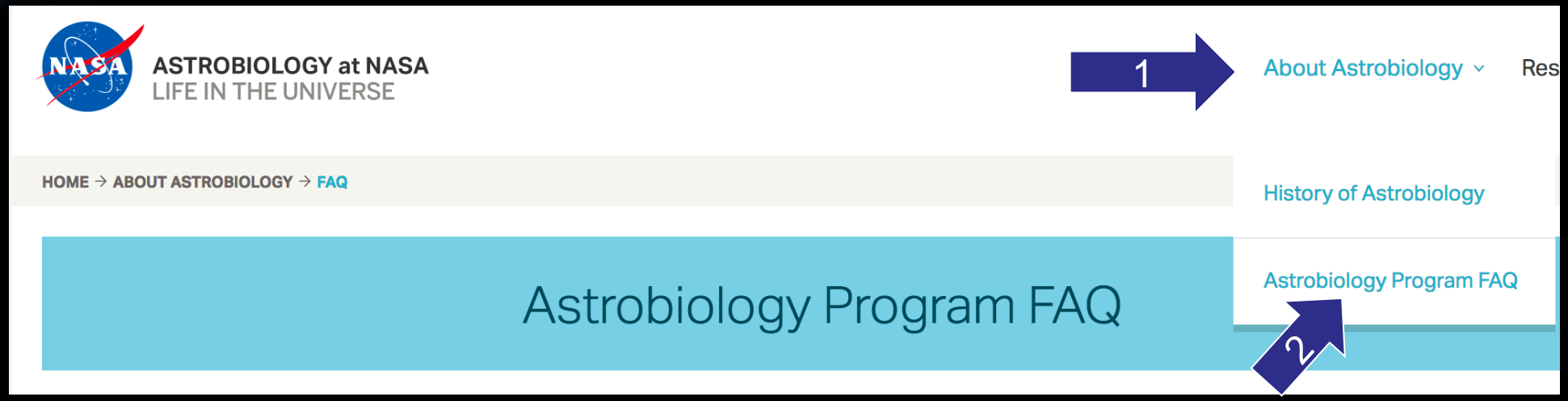
PCE$_3$ virtual meeting

- Workshop with primer talks about different major topics within RCN – to get everyone talking a common language
- Late-summer, 5 partial days, sufficient time for both presentations and group discussions

Earliest Cells to Multicellularity

Request for Information on themes, structure, and operation March 2020
Received 9 responses
Contributors spanned the notional scope

NASA Astrobiology Program - FAQs



This document contains answers to Frequently Asked Questions about the Astrobiology Program organized by topical areas:

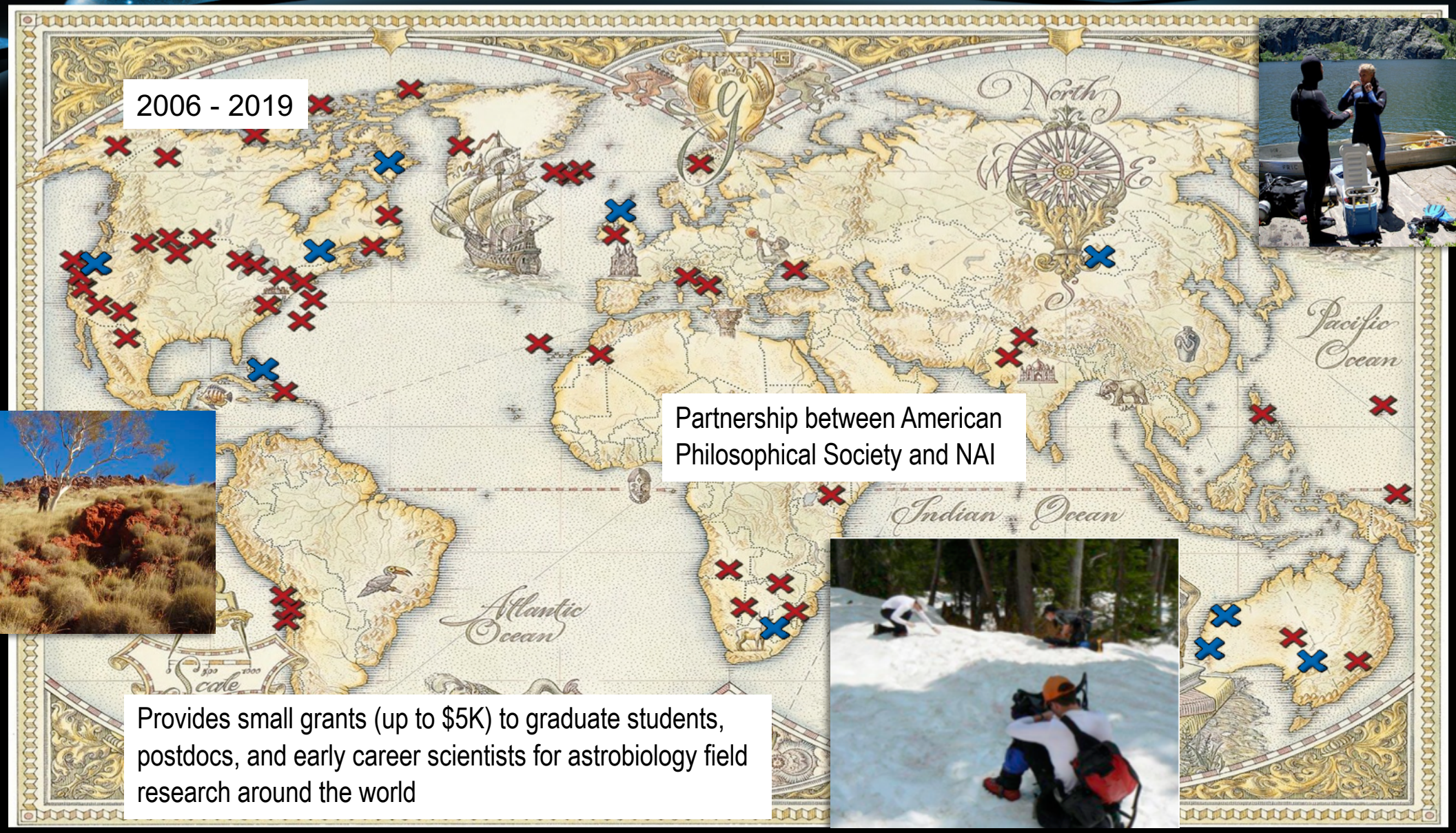
- NASA Astrobiology Program (goals, 2015 Strategy, history, contact)
- Funding Astrobiology Research (ICAR, Workshops, Early Career, topic-specific programs)
- Coordinating Astrobiology Research (RCNs: what, who, how)

The NASA Astrobiology Postdoctoral Program

- Since 2000, 125 Ph.D. scientists and engineers have been supported to conduct astrobiology research within the astrobiology program

- In 2010, the eligible advisors were expanded to include principal investigators selected for grants from the Astrobiology Program.

The Lewis & Clark Fund for Exploration and Field Research in Astrobiology



Partnership between American Philosophical Society and NAI

Provides small grants (up to $5K) to graduate students, postdocs, and early career scientists for astrobiology field research around the world

The Astrobiology Graduate Conference

The **Astrobiology Graduate Conference (AbGradCon**) is an annual meeting organized exclusively by and for graduate students and postdocs. The 15th AbGradCon was successfully held with roughly 100 participants in July 2019, in Salt Lake, Utah.

AbGradCon 2020 was scheduled to be held in Tokyo, Japan, When reschedule it will mark the fourth AbGradCon held outside of the continental US, encouraging greater interaction and collaboration amongst international astrobiologists. Support has been provided by the NASA Astrobiology Program, however the organizers have been increasingly successful in soliciting non-NASA support from foundations and scientific societies, who provide funding for international participants (e.g. Simons Foundation, Japanese Astrobiology Centre, Templeton, industry partners).

International Summer School in Astrobiology

Since 2002, the **International Summer School in Astrobiology** has been a joint program organized by the NAI and the Centro de Astrobiologia for 36 US and international students. The week includes eight lectures a field trip to a location of astrobiological significance, and group projects which are presented at the end of the week.

AbSciCon 2022

May 15-20, 2022, in Atlanta, Georgia

Next year’s theme is Origins and Exploration: From Stars to Cells.

Questions?

Diversity and Inclusion in Astrobiology

The **Astrobiology Faculty Diversity (AFD) Program**, formerly the **Minority Institution Research Support (MIRS) Program** has coordinated research sabbaticals, with researchers funded by the NASA Astrobiology Program, for 32 faculty members from Minority Serving Institutions (MSIs). Results have included increased publication of scientific papers, increased numbers of astrobiology graduate students from faculty laboratories, the employment of a student at GSFC and sustained collaboration.
https://astrobiology.nasa.gov/funding/nasa-astrobiology-faculty-diversity-program-former/

The **Minority Institution Astrobiology Collaborative (MIAC)** met in person the day prior to AbSciCon 2017. http://phl.upr.edu/projects/miac

A **survey** intended to measure the demographics od the astrobiology astrobiology community has been approved for distribution by the NASA Ames Research Center Human Research Institutional Review Board, and is will be distributed at AbSciCon 2019.

Diversity and Inclusion (cont)

- Plenary sessions focused on diversity and inclusion in the astrobiology community at AbSciCon 2017 and planned for AbSciCon 2019
- Staff member affiliated with GESTAR and MUSPIN programs at GSFC, focused on diversity at MSIs, mentoring students and partnering and outreach to many HBCUs

Astrobiology Learning Progressions

The Astrobiology Learning Progressions is a resource that provides direct connections between

- ***discipline-based, fundamental concepts in science*** that guide what teachers must teach and benchmark what students learn in which grades (as codified in the Next Generation Science Standards), and
- the ***interdisciplinary core concepts*** of astrobiology.

The AB LP's are a collection of interdisciplinary narratives—one for each of 23 different astrobiology concepts—each of which is presented four times, progressed in depth and sophistication through the grade bands (K-2, 3-5, 6-8, 9-12) and the spectrum of adult learning levels (naïve, emerging, building, sophisticated).

The AB LP's are meant to serve two primary audiences:

- Educators: supporting them to use astrobiology content to teach the discipline-based topics required by the standards
- Astrobiologists: supporting them to communicate with learners across the grade bands/spectrum, guiding them to tune their presentations to what learners at a particular level can reasonably be expected to know.

The project was initiated by the NASA Astrobiology Institute's (NAI) central office in 2015, and funded by the NASA Astrobiology Program

The development team is currently finalizing the integration of astrobiology learning materials/resources in alignment with each of the 23 progressed narratives.

https://astrobiology.nasa.gov/education/alp/

Organization and Structure

List of Core Learning Questions and Sub-Questions

1. How did matter come together to make planets and life in the first place?
   - 1.1: Are we really made of star stuff?
   - 1.2: How did our Solar System form?
2. How did Earth become a planet on which life could develop?
   - 2.1: What was the Earth like right after it formed?
   - 2.2: How was the Sun different when it formed compared to now?
   - 2.3: Where could life have gotten started on Earth?
3. What is life?
   - 3.1: What are the characteristics of life?
   - 3.2: What does life need for survival?
   - 3.3: What determines if a planet can have life?
   - 3.4: Why is water so important for life as we know it?
   - 3.5: How can we tell if something is alive or not?
4. How did life on Earth originate?
   - 4.1: Where do life's building blocks come from?
   - 4.2: What are the sources of life's building blocks within the Earth?
   - 4.3: What are the sources of life's building blocks outside the Earth?
5. How have life and Earth co-evolved?
   - 5.1: How did life first emerge on Earth?
   - 5.2: How did the first cells arise?
   - 5.3: How did life become something that competes for resources and evolves?
6. How has life evolved to survive in diverse environments on Earth?
   - 6.1: How did life on Earth come to occupy so many different environments?
   - 6.2: What types of conditions can life survive in?
   - 6.3: Are there environments beyond Earth that could be habitable?
7. How do we explore beyond Earth for signs of life?
   - 7.1: What is a biosignature?
   - 7.2: How do we explore within our own Solar System for signs of life?
   - 7.3: How do we discover worlds around other stars?
   - 7.4: How can we identify worlds around other stars that could have life?

6. How has life evolved to survive in diverse environments on Earth?

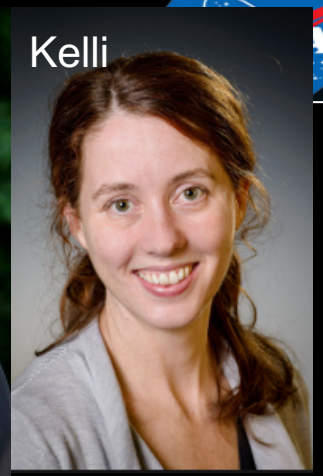
6.3. Are there environments beyond Earth that could be habitable?

Grades 3-5 or Adult Emerging Learner

Storyline | NGSS Connections for Teachers | Concept Boundaries for Scientists | Resources

When people go on vacation or go camping they to think about where they're going and make sure they pack all the kinds of things that they'll need. Maybe they'll take along enough clothes or food for their trip or maybe a tent or things for cooking. For people to live in the wild it can be pretty difficult, especially compared to how we usually live in our homes. However, there are many living things everywhere in this world and most of them don't need to pack a suitcase or take anything extra with them to live in the wild. That's because they're suited to the places in which they live. But what about beyond Earth? Do you think there are things that are suited to living on worlds like Mars or Venus or in other places in our solar system? One of the goals of astrobiology is to figure this out!

Astrobiology for the Incarcerated



Initiative to bring Science Programs to the Incarcerated (INSPIRE)
Nalini Nadkarni, Ph.D., University of Utah

Sustainability in Prisons Project (SPP)
Joslyn Trivett and Kelli Bush, The Evergreen State College

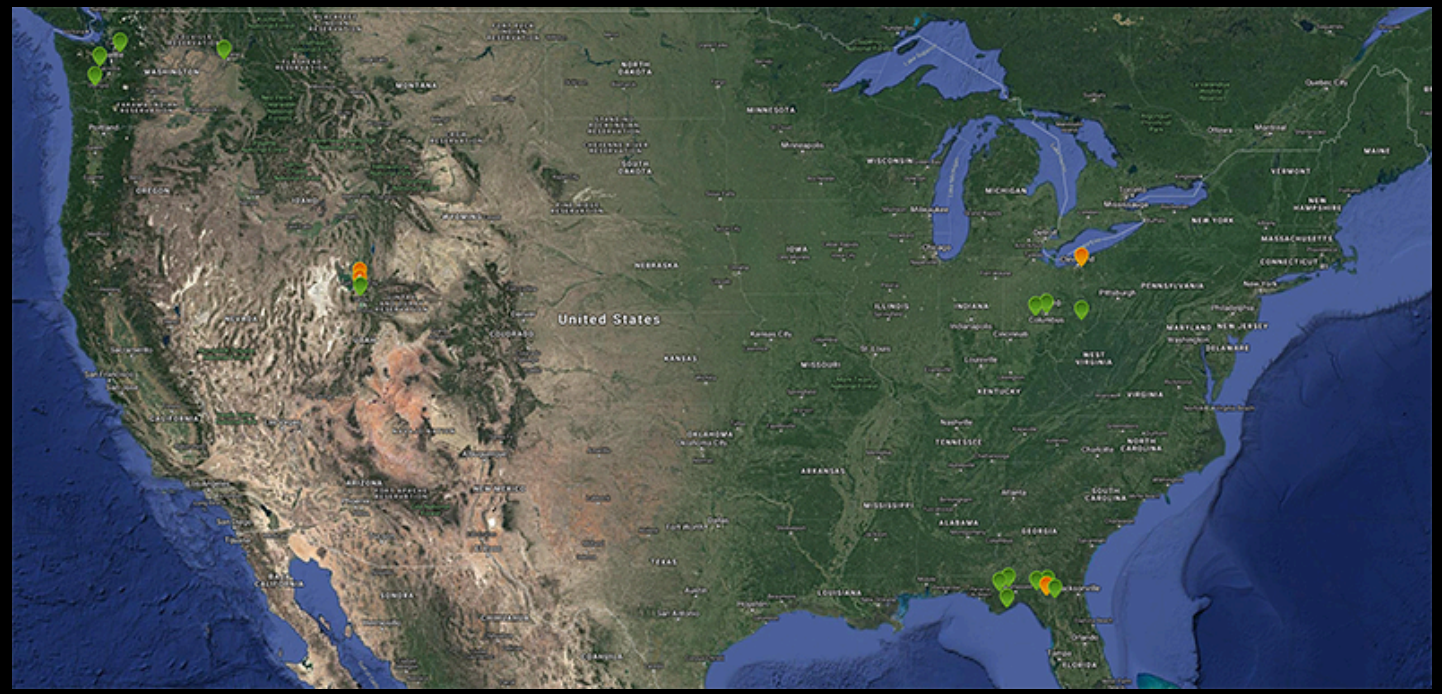
NASA Astrobiology Program
Daniella Scalice, NASA Ames Research Center

Relationship building since 2013, Partnership established in 2016

Programs piloted 2017-2019 with funding from NASA Astrobiology Program

- Astrobiology lecture given to **~1400 adults**
- Astrobiology hands-on program given to **~300** youth
- 26 facilities in four states (UT, WA, OH, FL)
- December, 2017 – March, 2019

- IRB-approved surveys administered; data collected from ~1000 matched-pairs (adults only)
  - Significant gains in content knowledge, value of science, science identity, and future actions
  - Manuscript in press now



Astrobiology for the Incarcerated

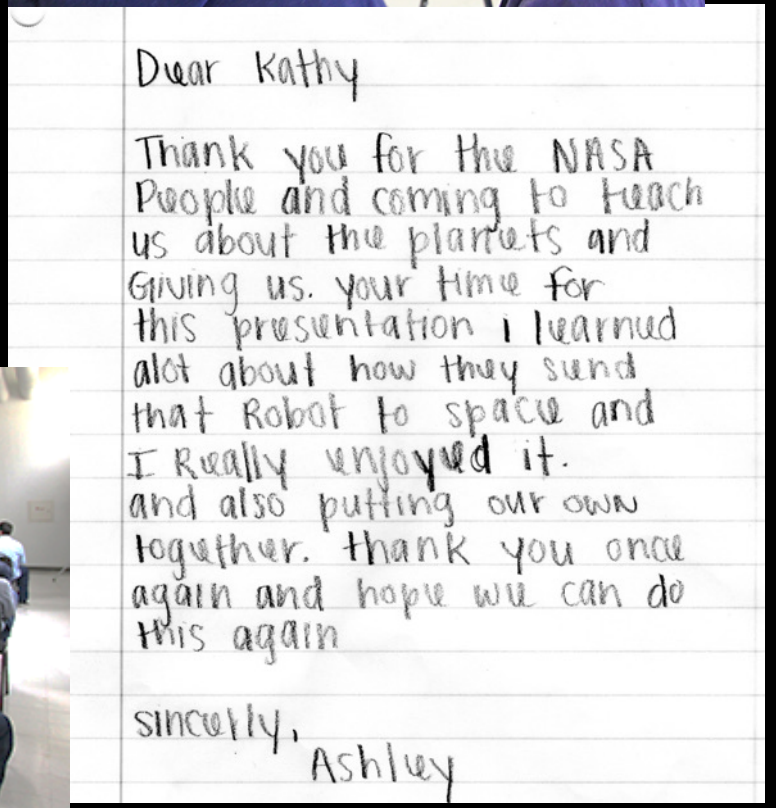
The program is ready for significant growth…

- 10-module, in-depth Astrobiology Course being developed now
  Pilot in OH facility later in 2020

- Focus on prison libraries
- Focus on educators in juvenile justice facilities

- AAAS Dialogue on Science, Ethics, and Religion partnering to train educators in communicating with audiences of faith

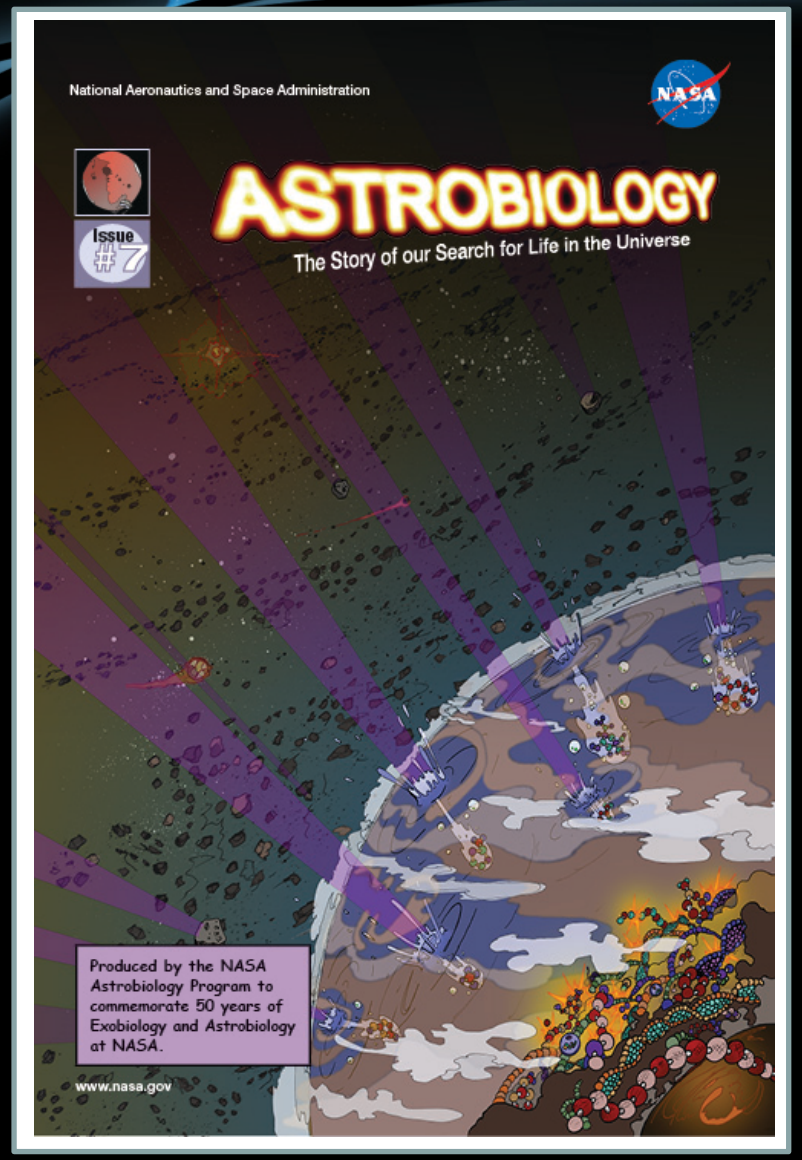
- SciAct teams and infrastructure are interested in partnering:
  - AMNH – Open Space
  - WGBH – general video collections
  - JSC – Lunar Discs Program
  - NASA Treks
  - JPL – Eyes
  - APOD
  - NISE Network
  - NASA @My Library
  - Solar System Ambassadors
  - NIA eClips
  - STScI - Universe of Learning
  - Scientific Visualization Studio
  - Night Sky Network
  - Northwest Earth and Space Sciences Pipeline



Dear Kathy

Thank you for the NASA People and coming to teach us about the planets and Giving us. your time for this presentation I learned alot about how they send that Robot to space and I Really enjoyed it. and also putting our own together. thank you once again and hope we can do this again

sincerly,
Ashley



Astrobiology

The Story of our Search for Life in the Universe

- Issue 1: Astrobiology's Beginnings
- Issue 2: Missions to Mars (4 Editions)
- Issue 3: Missions to the Inner Solar System (2 Editions)
- Issue 4: Missions to the Outer Solar System
- Issue 5: Analogs on Earth
- Issue 6: Exoplanets
- **Issue 7: Prebiotic Chemistry and the Origins of Life**

PCE$_3$ Community Workshop *October 5 – November 20, 2020*

PCE3 Co-Leads

Ram Krishnamurthy

Tim Lyons

Loren Williams

Karyn Rogers

Workshop Organizers

Dustin Trail

Jamie Elsila-Cook

Uli Muller

Workshop Facilitator

Andy Burnett – Know Innovation

Workshop Logistics

Maura Marsett (RPI)

Brenda Thomson (RPI)

Goal of the workshop: Integrate the early Earth and prebiotic chemistry communities and break down disciplinary barriers that stymie the pursuit of plausible prebiotic chemistry pathways.

The workshop took place over five weeks. Each of the five weeks addressed a different theme, from planetary formation to biochemical perspectives on the Origin of Life. 509 people registered in total.

On the Monday of each week, 4-6 'primer seminars' were posted via youtube. Each of the speakers gave state-of the art summaries of their respective discipline, accessible to non-specialists, highlighting points of agreements and debates, and designed to be 'neutral' with respect to specific models and opinions.

On the Friday of each week, a virtual meeting took place with breakout sessions. Participants in each group were asked to **Identify the most important avenues of research and/or questions within the respective theme that can transform Origins of Life research.** 255 people participated in at least one Friday Breakout Session.

In the breakout sessions, about 80% of participants remained in the discussion for 100 minutes.

	Theme 1 Earliest Planetary Evolution	**Theme 2 Evolution of the Near Surface**	**Theme 3 Inventories, Geological Settings, and Building Blocks**	**Theme 4 Prebiotic Complexity**	**Theme 5 Peering into the Past with Today's Biochemistry**
Date	Oct 5 - 9	Oct 12 - 16	Oct 19 - 23	Nov 9 - 13	Nov 16 - 20
Youtube views (as of Nov 24)	2,319	1,416	1,327	1,181	1,832
Friday Discussion participants	185	126	103	91	65

Planned output: An issue in Astrobiology, with a summary of the workshop, separate articles for the seminars, and a summary of the questions and research avenues that were identified as most important by the community. The workshop serves as foundation for the second PCE3 workshop planned for Spring 2021.

Analysis of the data from the workshop is currently ongoing, including metrics about the cross-disciplinarity and participant demographics.

3-7 AUGUST 2020

TECHNOCLIMES

AN ONLINE WORKSHOP TO DEVELOP A RESEARCH AGENDA FOR NON-RADIO TECHNOSIGNATURES