



**ExoPAG**

**TECHNO**  **SIGNATURE SAG**

Sofia Sheikh, on behalf of SAG 25

ExoPAG 31

January 11th, 2025



**?ETI**  
INSTITUTE



# A brief introduction to technosignatures



- “Technosignatures” = Astronomically-observable traces of technologically-capable life in the universe
- Sub-category of biosignatures
- Some technosignature detection techniques are directly analogous to biosignature techniques (e.g., CFCs in exoplanet atmospheres), others are unique (e.g., narrowband radio emission)
- Critical component to understanding the “origin, evolution, **distribution**, and **future** of life in the universe”



# Technosignatures SAG-25: Goals



1. Investigate which technosignature projects should play a role in NASA's portfolio
2. Identify the most promising technosignature investigations to prioritize for development
3. Identify science and technology gaps relevant to technosignature searches
4. Identify existing NASA programs most relevant to technosignature searches and determine how they can be more responsive to technosignature searches
5. Identify best practices for NASA program officers and review panelists to evaluate technosignature proposals in XRP and other programs
6. Identify potential new initiatives to build community and intercommunications with other astrobiology efforts

# SAG-25 Steering Committee



**Sofia Sheikh**



**Eddie Schwieterman**



**Daniel Angerhausen**



**Benji Fields**



**Jason Wright**



**Steve Croft**



**Mark Elowitz**



**Adam Frank**



**Megan Grace Li**

# Technosignatures SAG-25: Structure



- Steering Committee: **9 total leads**, 2 of which are executive secretaries
- Membership: **74 total members** across a range of career stages, sub-fields, and institutions
- Working Groups: Two larger groups on **Exoplanetary** and **Non-Exoplanet Technosignatures** (encompassing the first 4 goals), two smaller groups on **Proposal Review** (goal 5) and **Astrobiology Integration** (goal 6)



# Technosignatures SAG-25: Timeline



# Technosignatures SAG-25: Leadership in the NASA DARES RFI



- Organizing technosignature-related responses to the NASA DARES RFI (affiliate activity)

| Index | Lead Author(s)                   | Author Contact Information | White Paper Title  | Status                |
|-------|----------------------------------|----------------------------|--|-----------------------|
| 0     | Sofia Sheikh                     | ssheikh@berkeley.edu       | Technosignatures in the DARES Report: Motivation, Omnibus of Responses, and Resource Hub           | In draft stage        |
| 1     | Chenoa Tremblay / Joe Lazio      | ctremblay@seti.org         | Commensal Observations: An Emerging Opportunity for Astrobiology                                   | In draft stage        |
| 2     | Jason Wright                     | astrowright@gmail.com      | Exoplanet Technosignatures   | In draft stage        |
| 3     | Megan Grace Li                   | megangrace@g.ucla.edu      | Early-career groups in technosignatures strengthen community                                       | In draft stage        |
| 4     | Sofia Sheikh (+ SAG WG3 and WG4) | ssheikh@berkeley.edu       | Better Integrating Technosignatures in NASA's Approach to Biosignatures and Astrobiology           | In draft stage        |
| 5     | Jeremy Tregloan-Reed             | jtreed@setiap.org          | TBD (Detecting industrially-caused climate change on exoplanets through transmission spectroscopy) | Just idea, has leader |
| 6     | Dave DeBoer (?)                  | ddeboer@berkeley.edu       | TBD (Lunar Farside Radio Telescope)  | Just idea, has leader |
| 7     | ???                              | ???                        | TBD (Coherent direct EM SETI on a space-based mission)   | Just idea, no leader  |
| 8     | ???                              | ???                        | TBD (Encouraging more and easier cooperation with ground based facilities for projects)            | Just idea, no leader  |
| 9     | ???                              | ???                        | TBD (Post-detection paper out of the UK group?)  | Just idea, no leader  |

# Technosignatures SAG-25: Leadership in the NASA DARES RFI



- SAG Steering Committee is writing a technosignatures “**omnibus submission**” to the **DARES RFI**
- Will serve as a...
  - **Motivation** for the inclusion of technosignatures in DARES
  - **Omnibus** of other technosignature responses
  - **Hub** for recent technosignature literature/workshop reports

## Technosignatures in the DARES Report: Motivation, Omnibus of Responses, and Resource Hub

Sofia Sheikh, Jason Wright, Adam Frank, Edward Schwieterman,  
Other SAG Steering Committee Members

December 2024

### 1 Technosignatures and Astrobiology

Astrobiology is the study of the origin, evolution, distribution, and future of life in the universe. Finding life beyond Earth would greatly advance our understanding all of these topics, and is a primary goal within modern astrobiology. However, given that our *in situ* exploration is (for now) confined to the solar system, much of the search for life beyond Earth is dependent on searching for life's byproducts: using the methodology of astronomy to look for remotely-detectable biosignatures in electromagnetic radiation. The overwhelming diversity of life across its kingdoms on Earth — life that is both single- and multi-cellular, some life that shows intelligent or tool-using behaviour — leads to an equally diverse array of biosignatures on the surface, oceans, and atmosphere of our planet. For example, single-celled organisms can produce gaseous or atmospheric biosignatures such as CH<sub>4</sub> as direct or indirect products of metabolism [Schwieterman et al., 2018]. However, human technology also produces atmospheric constituents at levels that would be impossible from purely abiotic sources, e.g., NF<sub>3</sub> or SF<sub>6</sub>. These technosignatures are not metabolic, but distinctly imply the presence of humans, a technologically-capable species, on the surface of our planet. From this example, where the same methodology (the atmospheric characterization of exoplanets) could deliver the same discovery (life beyond Earth), it is straightforward to see that scientifically, technosignatures are a sub-category of biosignatures.

However, in NASA's last major astrobiology strategy document in 2015, technosignatures were not considered as part of astrobiology, or at least, not those that were delineated as “traditional SETI (Search for Extraterrestrial Intelligence)” [Authors and Reviewers, 2015]. Wright [2018] motivates the need for technosignatures' inclusion in a future NASA portfolio by outlining a few key ideas: worries of a “giggle factor” should not influence US science priorities; technosignature work is not an “all-or-nothing” proposition, and has led to significant scientific





# Technosignatures SAG-25: Working Group 3 Case Study

- WG3 Task 1: Identifying ROSES proposal calls in the last 10 years that are relevant to technosignature science

| Year | Division Letter | Division      | Number | Name and Link to ROSES-2024 Documentation  | ID # (for non-2024 calls) | Most recent ROSES appearance        | Initials of Skimmer | Relevance Score | Notes  |
|------|-----------------|---------------|--------|--|---------------------------|-------------------------------------|---------------------|-----------------|--|
| 2024 | A               | Earth Science | A.18   | <a href="#">Atmospheric Composition: Radiation Sciences Program</a>                          |                           | 2022                                | SZS                 |                 | Wrong link for 2022 - need to find correct one   |
| 2024 | A               | Earth Science | A.19   | <a href="#">Atmospheric Composition: Atmospheric Composition Modeling and Analysis</a>       |                           | 2024                                | SZS                 | 1               | Modelling for Earth atmosphere data, could be relevant. "pollution sourced aerosols where they impact cloud  |
| 2024 | A               | Earth Science | A.20   | <a href="#">Atmospheric Composition: Tropospheric Composition Program</a>                    |                           | Not Solicited In Last 10 Years      | SZS                 | 0               |  |
| 2024 | A               | Earth Science | A.21   | <a href="#">TEMPO/ACX Science and Applications Team</a>                                      |                           | 2024                                | MGL                 | 1               | One of the objectives is to model how pollution and climate change affect the atmosphere   |
| 2024 | A               | Earth Science | A.22   | <a href="#">NASA Energy and Water Cycle Study</a>  |                           | 2024                                | MGL                 | 0               | Solicited in 2025 - Research that understands the physical processes that drive hydrologic cycles, the atmosphere-ocean interface, and terrestrial water stores  |
| 2024 | A               | Earth Science | A.23   | <a href="#">Terrestrial Hydrology</a>  |                           | 2024                                | MGL                 | 0               | Research to understand hydrologic processes associated with the atmosphere-ocean interface, and terrestrial water stores   |
| 2024 | A               | Earth Science | A.24   | <a href="#">Weather and Atmospheric Dynamics</a>   |                           | 2024                                | MGL                 | 1               | Understanding for the physical processes that drive weather and climate, and physical processes for how weather works on earth and other planets.  |
| 2024 | A               | Earth Science | A.25   | <a href="#">Earth Surface and Interior</a>   |                           | 2024                                | MGL                 | 1               | Work using infrared data to measure thermal and chemical signatures - is there any work being done in this area? Includes space for " Exceptionally novel and innovative research that do not fit within ESD's current slate of solicitations at the time of writing. This would be a good way to use that new perspective." This is a call to use Radar data for understanding earth and other planets. |
| 2024 | A               | Earth Science | A.26   | <a href="#">Rapid Response and Novel Research in Earth Science</a>                           |                           | 2024                                | MGL                 | 2               |  |
| 2024 | A               | Earth Science | A.27   | <a href="#">NASA-ISRO Synthetic Aperture Radar Mission (NISAR) Research and Applications</a> |                           | 2023                                | MGL                 | 1               | This is a call to use Radar data for understanding earth and other planets.  |
| 2024 | A               | Earth Science | A.28   | <a href="#">Remote Sensing Theory for Earth Science</a>                                      |                           | 2024                                | MGL                 | 2               | General remote sensing call for any science that can be done from space  |
| 2024 | A               | Earth Science | A.29   | <a href="#">EMIT Science and Applications Team</a>   |                           | 2023 - not being offered until 2026 | MGL                 | N/A             | the link on 2023 links to a different proposal and the 2026 link is not yet available  |
| 2024 | A               | Earth Science | A.30   | <a href="#">Understanding Changes in High Mountain Asia</a>                                  |                           | 2023                                | MGL                 | 0               | I don't think encouraging a technosignature angle in this call   |

# Technosignatures SAG-25: Summary of SAG activities so far



- Established mission statement / list of goals
- Formalized steering committee
- Held open call for membership, accepted members
- Decided on Working Group structure and membership
- Held kickoff meeting (Nov. 2024)
- Holding initial Working Group meetings, undertaking WG goals (Jan. 2025)
- Leading and organizing submissions to the DARES RFI