



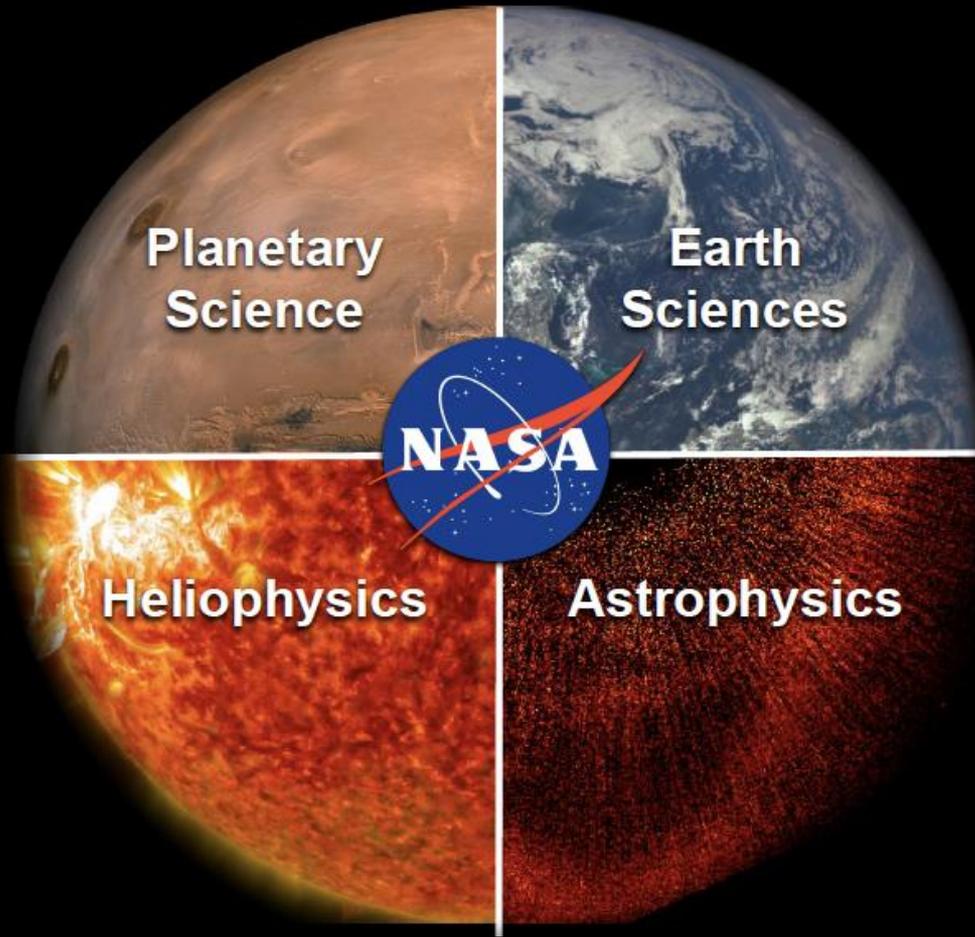
# NASA's Nexus for Exoplanet System Science: Working Together to Find Life in the Universe

(New!) NExSS Leadership:  
Ofer Cohen, Hilairy Hartnett,  
Jessica Noviello,  
Linda Sohl, and Rob Zellem



<https://nexss.info>

# NExSS Goals: Achieved by Interdisciplinarity



- Study planetary habitability and the search for life on exoplanets
- Answer fundamental questions related to planet formation, evolution, diversity, habitability, and signs of life
- Membership is open to any scientists working in NExSS science areas

# NExSS Science Goals

- Understand planets in context throughout their formation and coevolution with their parent star and planetary system
- Investigate the diversity of exoplanet characteristics and learn how their properties and evolution can create the conditions for life
- Understand how to identify the best exoplanet targets for life searches
- Learn how to recognize, and search for, signs of habitability and life on exoplanets.

# NExSS: Bringing the Community Together

NExSS builds community and advances our science with:

- **Interdisciplinary, inter-RCN Workshops and Conferences**, e.g. HabWorlds, Biosignatures, exoplanetary space weather, Technoclimes, EiOBY
- **Collaborative Exoplanet Observing Communities**, e.g., JWST ERS proposals, TRAPPIST-1 JWST Community Initiative, community contributions to Astro2020, OWL 2022 Decadal Surveys
- **Science Working Groups**, e.g. intermodel comparisons, habitability quantification, technosignatures and science communications
- **Quarterly Steering Committee (PI) meetings**, Slack Workspace w/working group/early career channels NExSS Newsletter, Website, Publication Bulletin, email lists

The collage consists of three main components:

- Top Image:** A screenshot of the "HABITABLE WORLDS" workshop overview page. It features a dark, rocky landscape under a moon. Text includes "AASTCO 8: Habitable Worlds Overview", "Join us 22-26 February 2021", and "The Habitable Worlds 2021 workshop will be fully virtual! Join the astronomy and planetary science communities for this dynamic online experience happening 22-26 February 2021." Navigation links for "Meeting Overview", "Meeting Schedule", "Registration is open!", and "Registrant List" are visible.
- Bottom Left Image:** The cover of the "NEXSS NEWSLETTER" for Summer 2021. It lists featured content: "Page 2 Upcoming Deadlines & Events", "Page 7 Attending AAS 242 in Albuquerque", "Page 12 Interview with Rob Zelle: New NExSS Co-Lead", "Page 15 Celebrating NExSS Success Stories", and "Page 16 Thank you, Dawn!". It is attributed to "the NExSS SCWG".
- Bottom Right Image:** A circular diagram titled "CUISINES model intercomparisons". The central circle is labeled "CUISINES". Surrounding it are various smaller circles representing different models and groups, including "MOCHA", "AUSPEX", "SAMBA", "RUBEC", "CUBES", "PIE", "BASIL", "EiOBY", "TRAPPIST-1", "JWST ERS", "ASTRO2020", "OWL", "TECHNOCLIMES", "BIOSIGNATURES", "EXOPLANETARY SPACE WEATHER", "EiOBY", "TRAPPIST-1", "JWST ERS", "ASTRO2020", "OWL", "TECHNOCLIMES", "BIOSIGNATURES", "EXOPLANETARY SPACE WEATHER".

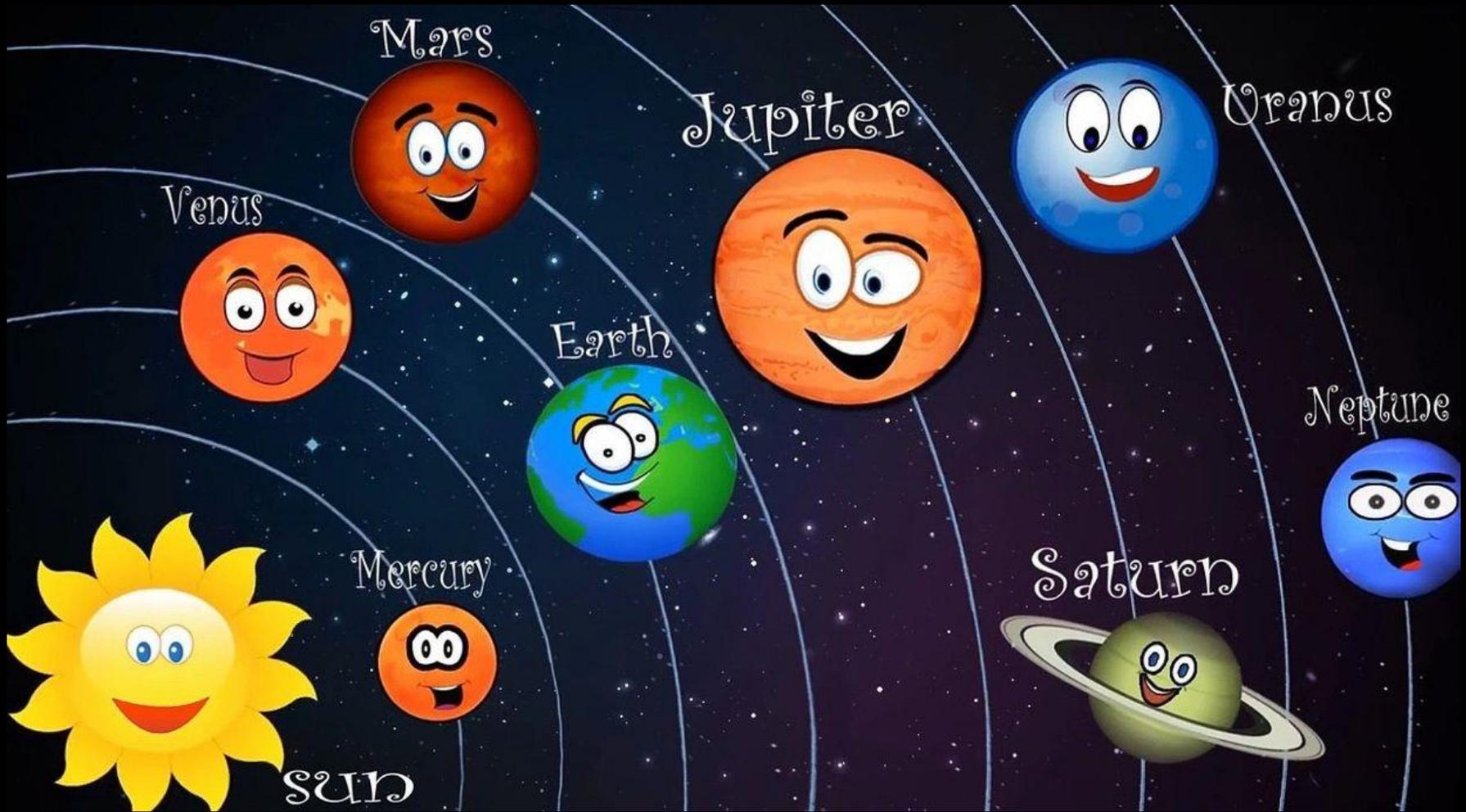
# NExSS Demographics

- NExSS members - anyone who is interested in NExSS activities  
NExSS members email list ~ 550 members
- NExSS steering committee - PIs (or CoIs) of a NExSS-affiliated grant can join the SC and participate in leading NExSS activities.

NExSS SC email list ~70 members (still in progress)

Program	# of active proposals
XRP	67
HW	15
ICAR (larger teams)	8
Exobiology	5
SSW	2
Planetary Science Early Career Award	1

# NExSS science outcomes through WG



# NExSS Working Groups

Working Group	Chairs
Science Communication Working Group (SCWG)	Jessica Noviello and Miles Currie
Quantitative Habitability	Daniel Apai and Rory Barnes
Climates Using Interactive Suites of Intercomparisons Nested for Exoplanet Studies (CUISINES)	Thomas Fauchez and Linda Sohl
Technosignatures	Adam Frank and Jacob Haqq-Misra
Life Detection	Stephanie Olson and Avi Mandell
Rocky Exoplanet Atmospheric Evolution through Time	Rajdeep Dasgupta and David Brain

# CUISINES

co-Chefs: Thomas Fauchez (GSFC) Linda Sohl (GISS)

- **CAMEMBERT**: exoplanet GCMs for Mini-Neptunes
  - Chef: Duncan Christie (Max Planck, Germany)
- **COD ACCRA**: 1D climate models
  - Chef: Guillaume Chaverot (Grenoble, France)
- **CRÈME**: exoplanet GCMs for Earth
  - Chef: Kostas Tsigaridis (GISS)
- **FILLET**: EBM for rocky exoplanets
  - Chef: Russell Deitrick (Victoria, Canada)
- **MALBEC**: radiative transfer codes
  - Chef: Geronimo Villanueva (GSFC)
- **MOCHA**: GCMs for hot/ultra hot Jupiters
  - Chef: Nicolas Iro (DLR, Germany)
- **PIE**: 1D photochemical models
  - Chef: Sonny Harman (Ames)
- **RISOTTO**: Retrieval models
  - Chef: Amber Young (GSFC)
- **SAMOSAS**: climate models sparse sampling
  - Chef: Jacob Haqq-Misra (BMSIS)
- **THAI**: GCMs for TRAPPIST-1e
  - Chef: Thomas Fauchez (GSFC)



# Technosignatures WG

Feb 29, 2023 Webinar

## **Expanding the Funding Frontier**

Covered the new ROSES call and the technosignature language in it.

Had lots of attendees and a robust discussion that included NASA HQ rep Josh Pepper

Work indirectly led to our new Study Analysis Group!

## QUANTITATIVE HABITABILITY SCIENCE WORKING GROUP

Launched in September 2020

Co-chairs: Daniel Apai (UArizona, Alien Earths)  
and Rory Barnes (UW, VPL)

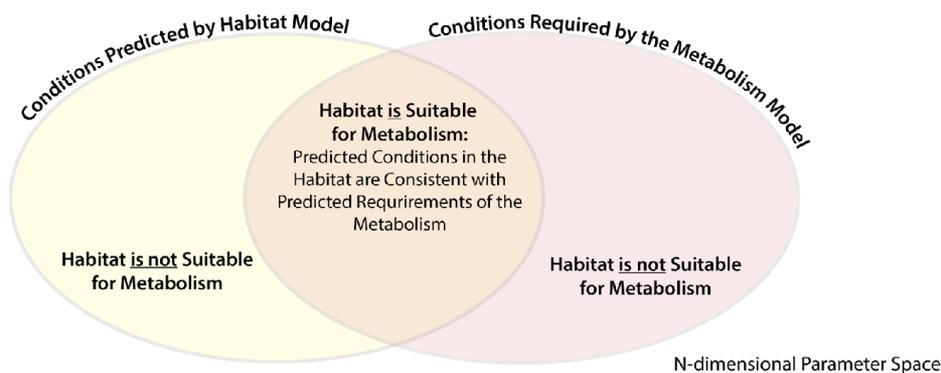
## STRONG ACTIVITY AND COMMUNITY INVOLVEMENT

- 3.5 years effort
- Slack channel, email list, web page
- Workshop (100+ participants)
- Bi-weekly meetings, ~20 seminars
- Overleaf working document
- Multi-disciplinary team including astro, geo, bio (+ecologists!)

## RESULTS

- New terminology, probabilistic/statistical assessment capability that considers uncertainties and multi-domain priors/constraints
  - Considers applicability to missions, i.e., specific enough but also provides self-consistent and flexible terminology
  - Developed QHF framework applicable to exoplanets and Solar System habitats
  - Includes initial library of habitats, metabolisms
  - Includes modular, open source python implementation
  - Examples for TRAPPIST-1e, -1f, Mars subsurface, Europa's ocean
- !!! Manuscript submitted to PSJ on April 28 !!!

### The Basis of the Quantitative Habitability Framework



ALIEN EARTHS

# New NExSS Teams





# The CHAMPs Team

Consortium on Habitability and Atmospheres of M-dwarf Planets

- Overarching Science Question
  - Can M-dwarf planets support life, and if so, how do we best observe and characterize them?
- Four Core Tasks
  1. M-dwarf Planetary Processes
  2. M-dwarf Planetary Atmospheres
  3. M-dwarf Star-Planet Interactions
  4. M-dwarf Exoplanet Observations
- Deliverables from one task are used as inputs into the next tasks
- JWST observations will yield quantitative constraints that feed back into models



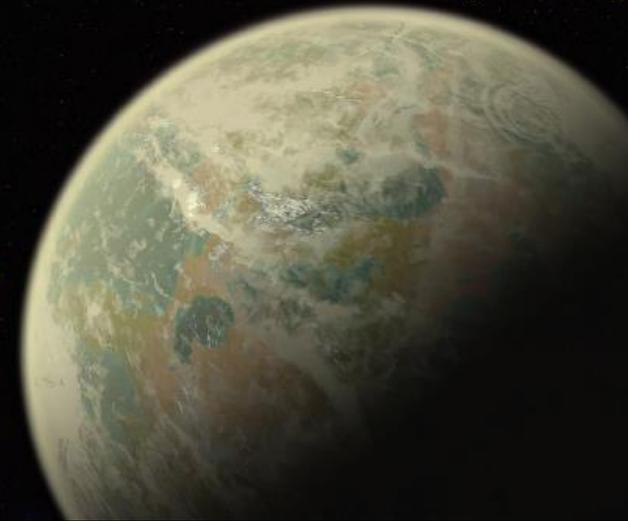
CENTER FOR  
ASTROPHYSICS  
HARVARD & SMITHSONIAN

## Strange New Worlds:

Characterizing Nearby M-dwarf Habitable Zone Planets

Program PI  
Kevin Stevenson  
(Johns Hopkins APL)

Science PI  
Ravi Kopparapu  
(NASA GSFC)





# Habitability Space: Exploring a New Frontier via Climate Models & Planetary Statistics

Michael Way  
Goddard Institute for Space Studies  
ROCKE-3D Team

**Theme 1** *Solar System Planetary Atmospheres Through Time*

The diagram shows a sequence of planetary images arranged in a grid. The top row shows three planets: a rocky planet, a planet with a thin atmosphere, and a gas giant. The middle row shows three planets: a rocky planet, a planet with a thin atmosphere, and a planet with a thick atmosphere. The bottom row shows three planets: a rocky planet, a planet with a thin atmosphere, and a planet with a thick atmosphere. To the right is a large, bright sun with solar flares.

**Theme 2** *Defining Planetary Characteristics*

The diagram shows a central sun with several elliptical orbits around it. To the right is a globe with a color gradient from blue to red. Five arrows point from the globe to five smaller globes, each with a different color gradient, representing different planetary characteristics.

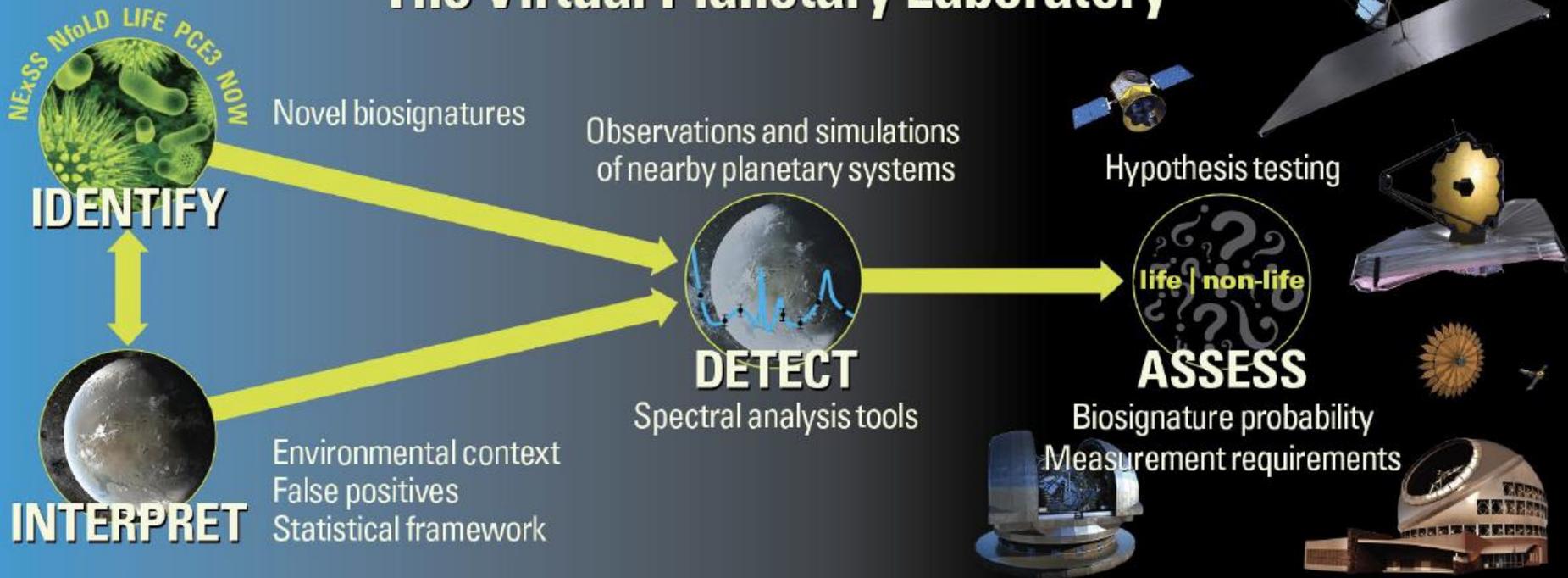
*Spin-orbit evolution modeling* *Perturbed Parameter Ensemble (PPE)*

**Theme 3** *PPE Subsampling, PSG Spectra, Linking to Telescope Data*

The diagram shows a grid of small globes on the left, representing PPE subsampling. An arrow points to a central globe with a spectrum overlaid, showing peaks labeled H<sub>2</sub>O and CH<sub>4</sub>. Another arrow points to a JWST telescope on the right, labeled JWST data.

*LHC subsampling* *PSG model spectra* *JWST data*

# The Virtual Planetary Laboratory



The VPL team focuses on the search for life on exoplanets, and will:

- create a “network of networks” with five RCNs to **identify** novel biosignatures in the context of early Earth environments
- understand environmental context and develop statistical frameworks to **interpret** biosignatures
- obtain JWST observations and simulate observations of planetary systems to **detect** terrestrial planetary characteristics, and
- use simulations and frameworks developed in the **identify**, **interpret** and **detect** tasks to **assess** to how well we can discriminate a living from a non-living local solar neighborhood using 25 HZ planet spectra from the Habitable Worlds Observatory.

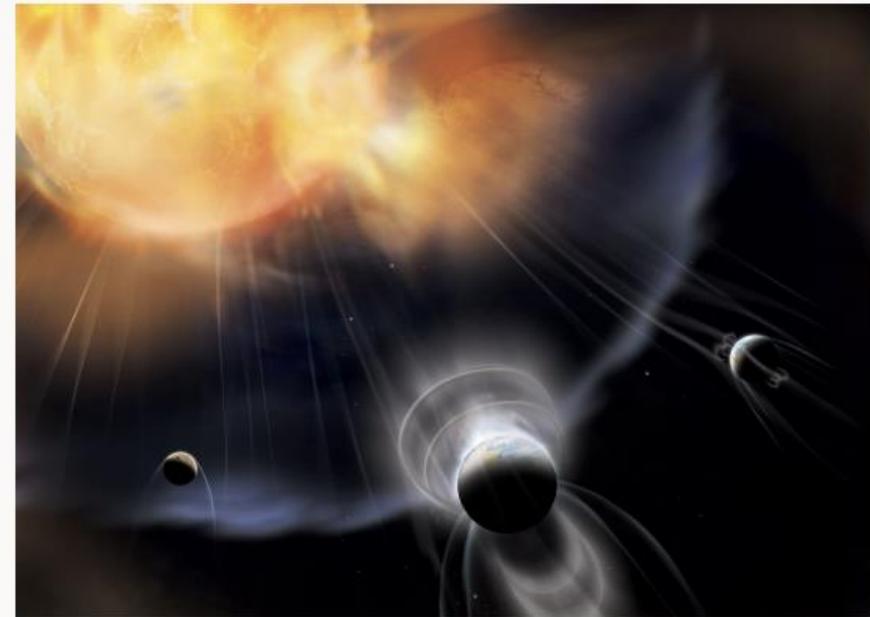
# Retention of Habitable Atmospheres in Planetary Systems

PI: Dave Brain (CU Boulder)



**How do the properties of a planet and its host star influence its ability to retain an atmosphere?**

- Objective 1:** Compute inputs for atmospheric escape for an ensemble of star-planet scenarios  
stellar EUV, stellar wind and magnetic field
- Objective 2:** Improve and link models for atmospheric escape from any planet  
12 redundant models for upper atmosphere and escape
- Objective 3:** Construct a multi-dimensional model library for atmospheric escape  
public web interface to entire library and synthesis
- Objective 4:** Apply the model library to understand the connection between atmospheric escape, habitability, and observations  
Atmospheric lifetimes, scaling laws, transit predictions



# Recent Events and Future Plans

- **BUFFET-3 workshop** in mid-October 2023 for CUISINES model intercomparisons in New York, NY and online
- **Venus workshops** in late October 2023 in Albuquerque, NM with a strong NExSS presence
  - VExAG meeting: October 30–31
  - Venus as a System Conference, Chapter 3: November 1–3
- **Habitable Worlds 3 workshop**: seeking leadership committee members now (date TBD)
- **Re-starting the webinar series**: NExSS recently underwent a programmatic review in early 2023; now assessing and incorporating recommendations
- **We are hoping for more interdisciplinary involvement**, particularly from the heliophysics division
- **New grand challenge** to catalyze broad community collaboration across the data-model divide for exoplanets

# Professional Advancement Workshop Series (PAWS)

- For early-career researchers to explore different career paths and hone new skills
- Space to network and learn together
- **Resources are available to anyone via the PAWS page on the NExSS website and the NExSS YouTube channel**
- Monthly events are paused for now, but the team received funding via TWSC for a week-long, fully virtual, *free to attend* PAWS event
  - More news to come on that soon!

PAWS website link



PAWS Team Lead: Jessica Noviello  
[Jessica.Noviello@nasa.gov](mailto:Jessica.Noviello@nasa.gov)



Co-leads: Shawn Domagal-Goldman  
(NASA GSFC) and Melissa Kirven-Brooks  
(NASA Ames Exobiology Branch & the  
NASA Astrobiology Program)

# NExSS Leadership Changes

## HQ Reps

Mary Voytek (PSD)  
Richard Eckman (ESD)  
Doug Hudgins (APD)  
Jared Leisner (HPD)

## Co-Leads

Daniel Apai (U. Arizona)  
Dawn Gelino (IPAC/NExSci)  
Victoria Meadows (U. Washington)  
Shawn Domagal-Goldman (GSFC)

## NExSS NASA Postdoc

Jessica Noviello (GSFC)

2023-2024

## HQ Reps

Lindsay Hays (PSD)  
Richard Eckman (ESD)  
Hannah Jang-Condell (APD)  
Jared Leisner (HPD)

## Co-Leads

Ofer Cohen (U. Massachusetts, Lowell)  
Hilairy Hartnett (Arizona State U.)  
Linda Sohl (Columbia/NASA GISS)  
Rob Zelle (GSFC)  
Jessica Noviello (GSFC)



# You Can Get Involved in NExSS!

- **Three mechanisms:**

- Be a member of a relevant, accepted NASA proposal
- Participate in our workshops, conferences and other community activities
- Join as a NExSS affiliate:

<https://nexss.info/about/nexss-affiliates/>



^From the Exoplanets in Our Backyard 2 meeting in Albuquerque, NM, Nov 2022

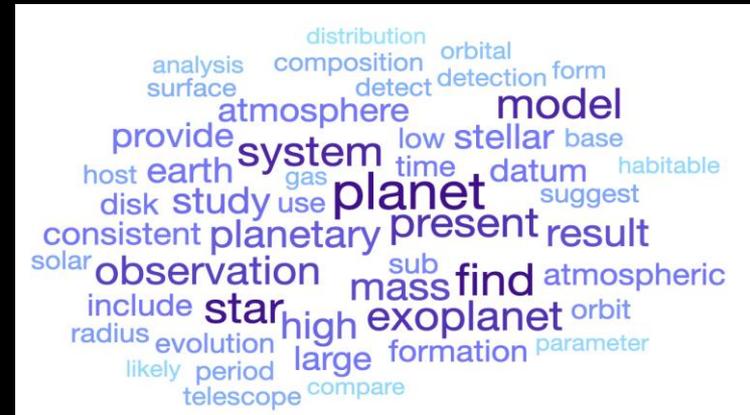


- **Join NExSS to get access to:**

- Email Announcements
- Publication bulletins
- Newsletters
- Slack workspace access



<https://nexss.info>



<https://nexss.info/> • [@nexssinfo](https://twitter.com/nexssinfo) • <https://manyworlds.space/>