

National Aeronautics and  
Space Administration



# EXPLORESCIENCE

**Research and Analysis (R&A)**

*Decadal Survey Supplemental Presentation*

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# Introduction

This input to the Decadal Survey presents high-level information on the current state of the Heliophysics Division Research and Analysis (R&A) program. The intent of these slides is to assist the Committee in the beginning of their deliberations, and NASA welcomes the opportunity to speak further to the Committee on this topic.

# Overview

- Heliophysics Research structure, evolution
- Heliophysics ROSES Programs
  - ROSES-2022
  - Community-Development Programs
  - Cross-Divisional Programs
  - Open Science Investments
- Heliophysics DRIVE Centers



The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a warm, golden-yellow and greenish glow, suggesting a different spectral filter or a different region of space. The text 'Heliophysics Research' is centered in a white, sans-serif font across the middle of the image.

# Heliophysics Research

# Evolution of Heliophysics Competed Research

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<i>Earth Sun System</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>	<i>Heliophysics</i>
SH SR&T (2)	SH SR&T (3)	SH SR&T (3)	SH SR&T (3)	SH SR&T (3)	SH SR&T (3)	SH SR&T (3)	SH SR&T (3)	H-SR	H-SR	H-SR	H-SR	H-SR	H-SR	H-SR	H-SR	H-SR
Geo SR&T (2)	Geo SR&T (3)	Geo SR&T (3)	Geo SR&T (3)	Geo SR&T (3)	Geo SR&T (3)	Geo SR&T (3)	Geo SR&T (3)	H-TIDeS	H-TIDeS	H-TIDeS	H-TIDeS	H-TIDS	H-TIDeS	H-TMS	H-TMS	H-TMS
SH LCAS	H Theory	H Theory	H Theory	H Theory	H Theory	H Theory	H Theory	H-GI	H-GI	H-GI	H-GI	H-GIO	H-GIO	H-GIO	H-GIO	H-GIO
Geo LCAS	HGI	HGI	HGIP	HGIP	HGIP	HGIP	HGIP	H-GCR	H-GCR	H-GCR	H-GCR	H-GCR	H-GCR TMS	GIGI	LWS Science	LWS Science
S3C Theory	LWS TR&T	LWS SET	LWS TR&T	LWS TR&T	LWS TR&T	LWS TR&T	LWS TR&T	H-LWS	H-LWS	H-LWS	H-LWS	H-LWS	H-LWS Science	LWS Science	LWS SC	LWS SC
GI	Vir Obs	LWS TR&T	LWS TR&TSC	LWS TR&TSC	LWS TR&TSC	LWS TRT NSF	LWS TR&TSC	H-IDEE	H-IDEE	H-IDEE	H-IDEE	H-DEE	H-DEE	H-DEE	SWO2R	SWO2R
LWS TR&T	LWS C/NOFS	LWS TR&TSC	Vir Obs	HDEE	HDEE	HDEE	HDEE				MMS GI	MMS GI	GIGI	H-TIDeS	H-TIDeS	H-TIDeS
SEC IDP		Vir Obs	SDO Sci Ctr	CCMSC							H-GCR SC	H-GCR SC	H-GCR SC	H-FORT	H-LCAS	H-LCAS
Virtual Obs			HGIS CNOFS								USPI	ECIP	ECIP	LWS SC	H_FOS	H_FOS
C/NOFS											Eclipse	SWO2R	USPI	HDEE	H-FORT	H-FORT
													SWO2R	USPI	HDEE	HDEE
													Drive Centers	OH-GI	USPI	USPI
													SWO2R 2	HSO DS	ECIP	ECIP
														HSO C	GIGI	GDC IDS
															PSP-GI	H MCS
															Eclipse	Eclipse
															HERMES IDS	LWS T&M

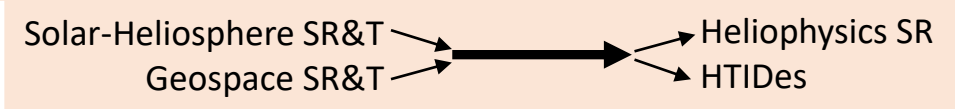
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**[2005]** Science Mission Directorate formed from Office of Earth Science and Office of Space Science.  
Heliophysics science was supported by the Earth Sun System Division.

**[2006]** SMD created the Heliophysics Division from the Earth Sun System Division.

**[2013]** Heliophysics Division reorganized its competed research programs.



# Heliophysics Competed Research (2022)

## R&A

Heliophysics Supporting Research

Theory, Modeling and Simulation

Low-Cost Access to Space

Flight Opportunities for Research & Technology

Data Environment Enhancements

U.S. Participating Investigators

Early Career Investigators Program

Innovation in Technology and Science

Eclipse 2024

Citizen Science Medium

Heliophysics Tools and Methods

## Living With a Star

Living With a Star Science (Focus Topics)

Tools and Methods

Strategic Capabilities

Infrastructure (Jack Eddy Fellows)

## Space Weather

Science Applications  
Research-to-Operations-to-Research

Space Weather Centers of Excellence

## Guest Investigator

Guest Investigators Open

Targeted Guest Investigators  
(e.g. ROSES-2021 GOLD-ICON, ROSES-2021 Parker Solar Probe)

## Technology

Technology and Instrument Development for Science

Flight Opportunities Studies





# Research Opportunities in Space and Earth Sciences (ROSES)

# Heliophysics ROSES-2022 Solicitations [1]

Appendix	ROSES Program Element	Cadence	Award Duration (Years)	Program
B.2	H-Supporting Research	Annual	3	R&A
B.3	H-Theory, Modeling, and Simulation	Every 3 Years	3	R&A
B.4	H-Guest Investigator Open	Annual	3	Guest Investigator
B.5	Living With a Star Science	Annual	4	Living With a Star
B.6	Living With a Star Capabilities	Irregular	4	Living With a Star
B.7	SWxSA R2O2R	Annual	2	Space Weather
B.8	H-Tech. and Instr. Dev. for Sci.	Annual	4	Technology
B.9	H-Low Cost Access to Space	Annual	4	R&A
B.10	H-Flight Opportunities Studies	Annual	1	Technology
B.11	H-Flight Opps. for Res. and Tech.	Annual	5	Technology
B.12	H-Data Environment Enhancements	Quarterly	1	R&A
B.13	H-U.S. Participating Investigator	Irregular	Variable	R&A

<https://solicitations.nasaprs.com/ROSES2022>



# Heliophysics ROSES-2022 Solicitations [2]

Appendix	ROSES Program Element	Cadence	Award Duration (Years)	Program
B.14	H-Early Career Investigator Program	Every 2 Years	4	R&A
B.15	H-Innovation in Tech. and Sci.	Quarterly	1	R&A
B.16	H-AI/ML-Ready Data*	Annual	1	R&A
B.17	Interdisciplinary Science for Eclipse*	Special Prog.	1	R&A
B.18	Living With a Star Tools and Methods	Irregular	1	Living With a Star
B.19	H-Living With a Star Infrastructure	Every 5 years	5	Living With a Star
B.20	Heliophysics Tools and Methods*	Quarterly	1	R&A
B.21	H-Citizen Science Investigations*	Annual	3	R&A
B.22	Space Weather Centers of Excellence*	Special Prog.	5	Space Weather

\*New in ROSES-2022

<https://solicitations.nasaprs.com/ROSES2022>



# Community-Development Programs

- [Future Investigators in NASA Earth and Space Science and Technology \(FINESST\)](#)
  - This program supports graduate student-designed and performed research projects that contribute to the Science Mission Directorate's (SMD's) science, technology and exploration goals. FINESST awards research grants with a research mentor as the principal investigator and the listed graduate student listed as the "student participant".
  - Supports investigations in all research regimes of Heliophysics, that focus on space weather-relevant processes, and/or that address a systems approach to the science
- [Early-Career Investigator Program \(ECIP\)](#)
  - This program supports outstanding scientific research and career development of scientists at the early stage of their professional careers. The program aims to encourage innovative research initiatives and cultivate diverse scientific leadership in Heliophysics.
  - This program fosters the empowerment, inspiration, and education of the next generation of space researchers, as part of the DRIVE (Diversify, Realize, Integrate, Venture, Educate) initiative.
- [Jack Eddy Fellowship](#) (Living With a Star)
  - This prestigious fellowship program is named after pioneering solar researcher John A. "Jack" Eddy. It is a two-year fellowship to train the next generation of heliophysics researchers, and matches early-career PhDs with experienced scientists at U.S. host research institutions.
  - Supported by HPD, managed in [LWS Infrastructure program](#)



# ROSES Cross-Divisional Efforts

HPD is active in several cross-divisional or multi-disciplinary efforts within ROSES:

- [Exoplanets Research Program \(XRP\)](#) [ROSES F.3]
  - Basic research proposals to advance our knowledge and understanding of exoplanetary systems
- [Habitable Worlds \(HW\)](#) [ROSES F.4]
  - Basic research proposals about processes and conditions that create and maintain potentially habitable environments
- [Citizen Science Seed Funding Program](#) [ROSES F.9]
  - Incubates citizen science projects as they are being conceived or during critical transitions
- [Artemis Deployed Instruments Program](#) [ROSES F.12]
  - Proposals for instruments to be deployed on the surface of the Moon during the first crewed lunar landing
- [Transform to OPen Science \(TOPS\) Training](#) [ROSES F.14]
  - Proposals for the development of Open Science learning curriculum to advance open science literacy, and capacity building through one-day meetings, workshops, and summer schools





# Open Science Strategic Investments

## **Continuous Evolution of Data and Computing Systems**

- Heliophysics Digital Resource Library (HDRL): Evolving the Heliophysics Archives (SPDF, SDAC) and supporting elements
- Heliophysics AI/ML-Ready Data (H-ARD): New ROSES element to create AI/ML-ready data sets
- Heliophysics content in the Astrophysics Data System (ADS)
- Heliophysics Data Environment Enhancements (HDEE): On-going ROSES program element
- Heliophysics Tools and Methods (HTM): New ROSES program element
- Inclusion of data storage for Low-Cost Access to Space projects (NEW REQUIREMENT)

## **Harness the Community and Strategic Partnerships for Innovation**

- Amazon Web Services (AWS) machine learning: Application of new ML techniques to find new science
- High-end computing (HEC) computing power upgrades every 1-2 years
- Frontier Development Labs develop AI enhanced work-flows and solutions with peers from the data sciences (plans to modestly fund FDL topics being supported through UCAR/LWS residual funds)
- Coordinated Community Modeling Center (CCMC) activities with LWS and Space Weather

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# Heliophysics DRIVE Centers

# Heliophysics Science Centers

- Heliophysics Science Centers implemented following National Academies recommendations, advice
  - 2013 Heliophysics Decadal Survey
    - Recommended as part of DRIVE (Diversify, Realize, Integrate, Venture, Educate) initiative
  - Committee on Solar and Space Physics report: Heliophysics Science Centers [2017]
- Centers are structured differently than most NASA competed research awards [[HPAC, June 2020](#)]
  - Implemented as a NASA-NSF partnership
  - Mechanism for significant scientific advances
    - Potential for breakthrough science within 5-year lifetime
  - Required to incorporate enabling elements
    - Diverse, multi/inter/trans-disciplinary, and fully integrated team
    - Supportive infrastructure and management system
    - Broadening impacts: Creative, substantive activities enhancing education, diversity, and public outreach
- DRIVE Science Centers
  - [Phase I](#) selections: December 2019
  - [Phase II](#) selections: March 2022
- Space Weather Centers of Excellence
  - Uses framework established by DRIVE Science Centers, focuses on R2O2R activities
  - [Phase I](#) solicitation: ROSES 2022
  - Phase I selections: Q4 2022/Q1 2023 (est.)



# DRIVE Science Center Selections

- Consequences of Flows and Fields in the Interior and Exterior of the Sun ([COFFIES](#))
  - *PI:* J. Hoeksema / Stanford University
  - COFFIES establishes a collaborative science community to develop comprehensive models of solar dynamics that will substantially improve the physical understanding of the ways internal plasma flows affect the origin and evolution of magnetic activity cycles of the Sun and stars like it.
- Center for Geospace Storms ([CGS](#))
  - *PI:* V. Merkin / Johns Hopkins Univ./APL
  - CGS's vision is to transform the understanding and predictability of space weather. This center will pursue innovation, empowerment, and discovery to improve space weather modeling and research.
- Solar wind with Hydrogen Ion charge Exchange and Large-Scale Dynamics ([SHIELD](#))
  - *PI:* M. Opher / Boston University
  - SHIELD's vision is to understand the nature and structure of the heliosphere. It is a novel effort to define, quantify, and implement all relevant physical processes to develop a "digital twin" of the heliosphere.



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#HelioRocks