

# Heliophysics Digital Resource Library (HDRL) & Open Science

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# OVERVIEW

1. The Heliophysics Digital Resource Library (HDRL)
2. Open Science in Heliophysics
3. Going forward

# WHAT IS HDRL?

- Managed at the Goddard Space Flight Center Heliophysics Science Division, HDRL is a federation of archives focused on user driven acceleration of heliophysics science
- HDRL is where the Heliophysics System Observatory (HSO) comes together
- HDRL enables the scientific analysis goals of the HSO
  1. Provisions and curates big data – PB volume
  2. Supports data analysis and modeling in multiple computational environments
  3. Designs and implements collaborative open science infrastructure





### HP Data and Model Consortium (HDMC)

**Brian Thomas (Acting PS),  
Tressa Helvey-Kasulke (PM)**  
*Overall management of the HDRL.*  
*Registries and DOIs for all digital resources; SPASE Data Model.*  
*Heliophysics Data Portal (HDP; including solar)*  
*Python and other software integration (PyHC).*  
*Analysis and visualization services ((Py)SPEDAS, Autoplot).*  
*Data upgrades and services.*  
*HelioCloud initiative with data and software from all groups.*

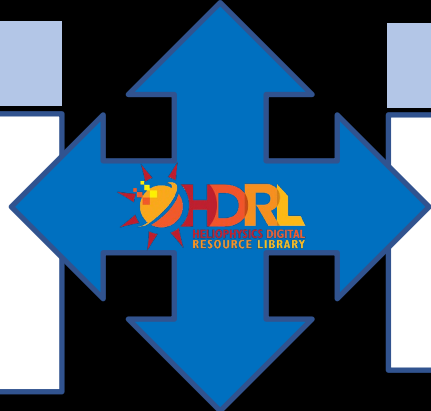
All activities within the various HDRL components are interrelated.

### Space Physics Data Facility (SPDF)

**Robert Candey (PS), Lan Jian (DPS)**  
*Non-solar Data Final Active Archive for NASA (and other) missions.*  
*CDAWeb data browsing and access; Web Service access.*  
*OMNIWeb data production and serving.*  
*SSCWeb and 4-D spacecraft orbit facility. Common Data Format.*

### Solar Data Analysis Center (SDAC)

**Jack Ireland (PS)**  
*Solar Data Final Active Archive for Solar Dynamics Observatory and other NASA missions.*  
*Virtual Solar Observatory data access.*  
*Helioviewer. SolarSoft. SunPy.*  
*High Performance Computing for NASA HP.*



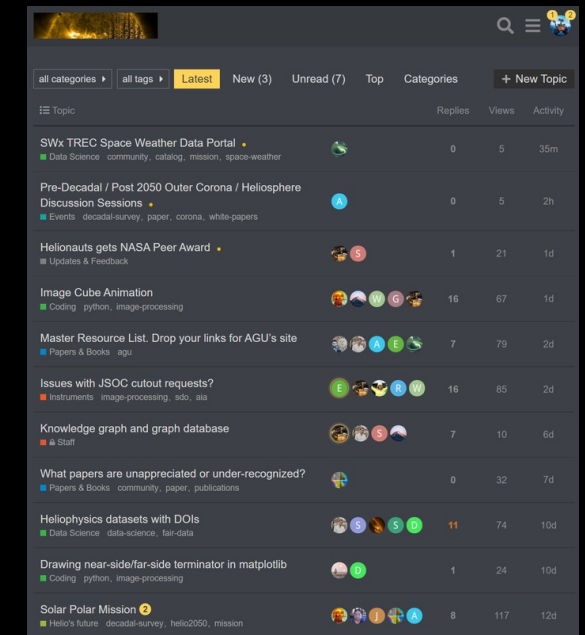
### Collaborators

**Community Coordinated Modeling Center**  
*Data-model comparisons; Registry of models and output; "Kamodo" enabled visualization.*

**Center for HelioAnalytics**  
*Mission-Enabling Tech, Community Resources, User Testing*

# HDRL Highlights

- HelioCloud pilot program
  - ~135 active cloud users,
  - 10 active research groups
  - Helionauts, LWSTM, Helioanalytics, Helioviewer, etc.
  - >600TB of data including from SDAC & SPDF
- HDRL outreach
  - Data, Analysis, and Software in Heliophysics (DASH)
  - International Heliophysics Data Environment Alliance (IHDEA)
- Python in Heliophysics Community (PyHC) program
- HDRL Open Science
  - New staff to focus on Open Science support
  - Digital librarian



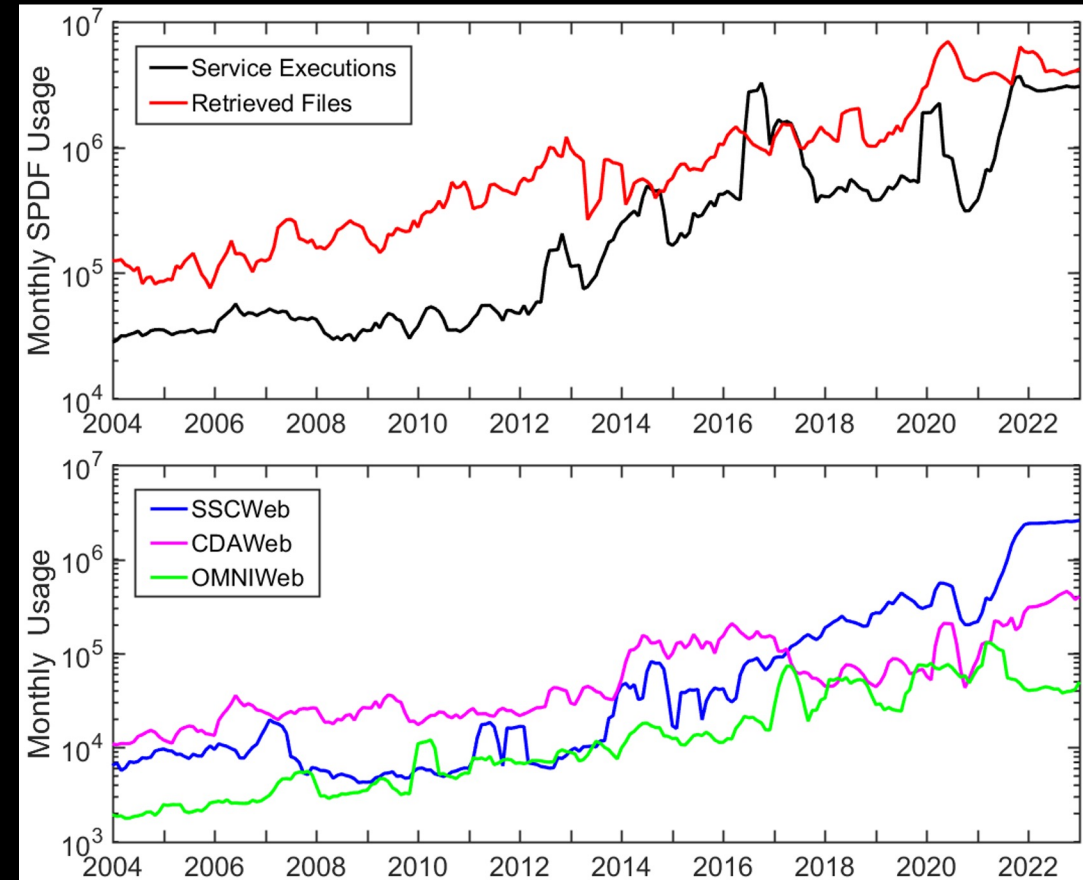
A screenshot of a forum or social media page with a dark theme. The page shows a list of posts with columns for Topic, Replies, Views, and Activity. The posts are as follows:

Topic	Replies	Views	Activity
SWx TREC Space Weather Data Portal Data Science community, catalog, mission, space-weather	0	5	35m
Pre-Decadal / Post 2050 Outer Corona / Heliosphere Discussion Sessions Events decadal-survey, paper, corona, white-papers	0	5	2h
Helionauts gets NASA Peer Award Updates & Feedback	1	21	1d
Image Cube Animation Coding python, image-processing	16	67	1d
Master Resource List. Drop your links for AGU's site Papers & Books agu	7	79	2d
Issues with JSOC cutout requests? Instruments image-processing, sso, aia	16	85	2d
Knowledge graph and graph database Staff	7	10	6d
What papers are unappreciated or under-recognized? Papers & Books community, paper, publications	0	32	7d
Heliophysics datasets with DOIs Data Science data-science, fair-data	11	74	10d
Drawing near-side/far-side terminator in matplotlib Coding python, image-processing	1	24	10d
Solar Polar Mission Helio's future decadal-survey, helio2050, mission	8	117	12d

# Space Physics Data Facility (SPDF)

- SPDF archives the in-situ data from NASA heliophysics missions and other divisions and partners
- SPDF provides **three science-enabling services**:
  - Coordinated Data Analysis Web (CDAWeb)
  - Satellite Situation Center (SSCWeb)
  - OMNIWeb and COHOWeb
- **Data variety**: ~2300 datasets in CDAWeb + 1000 more not in CDAWeb, from ~280 missions/projects (space missions, ISS, rockets, balloons, ground instruments...)
- SPDF enables multi-instrument, multi-mission science
- SPDF builds critical infrastructures for HDRL
  - Self-describing Common Data Format (CDF)
  - ISTEP/IACG/SPDF metadata standards

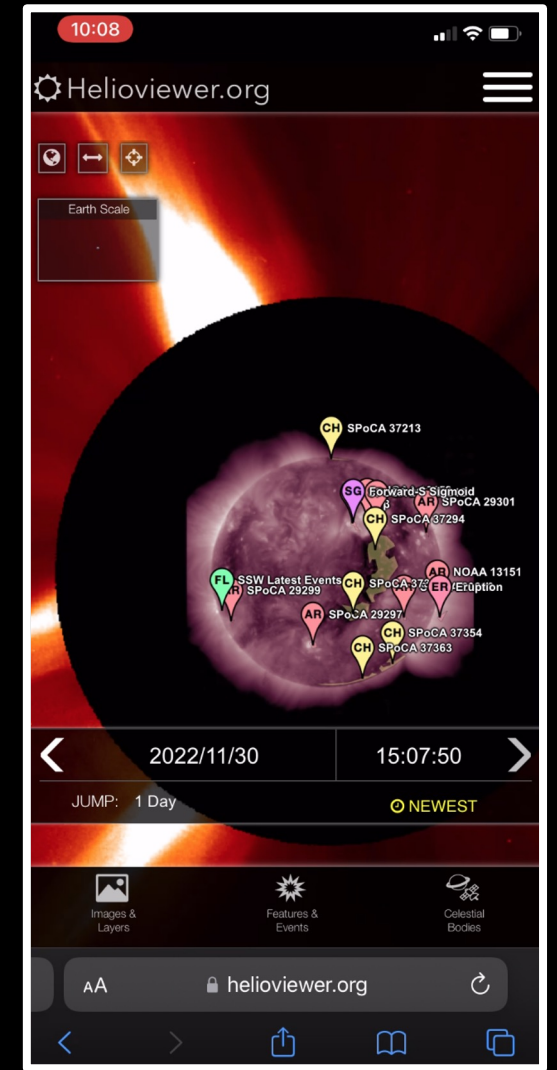
SPDF and its services are cited by ~40% of the main space physics journal papers in 2022.



> 563 TB of compressed data, > 174 M data files  
200 M service requests and > 600 TB egress volume

# Solar Data Analysis Center (SDAC)

- SDAC Supports the curation, provision, and analysis of solar physics data
- SDAC supports over 51 instruments (including missions, sounding rockets, and cubesats)
- >1.4 PB of total data
- Collaboration with National Center for Climate Simulation to collocate multi-PB of data on premise with HEC
- Developing Heliophysics Event Knowledgebase (HEK) to include non-solar event data
- Develops the Helioviewer.org page



*Helioviewer : screenshot of the web application running on a mobile phone.*

# Open Science



Principle and practice of making research products and processes available to all, while **respecting diverse cultures**, maintaining security and privacy, and **fostering collaborations**, reproducibility and **equity**.

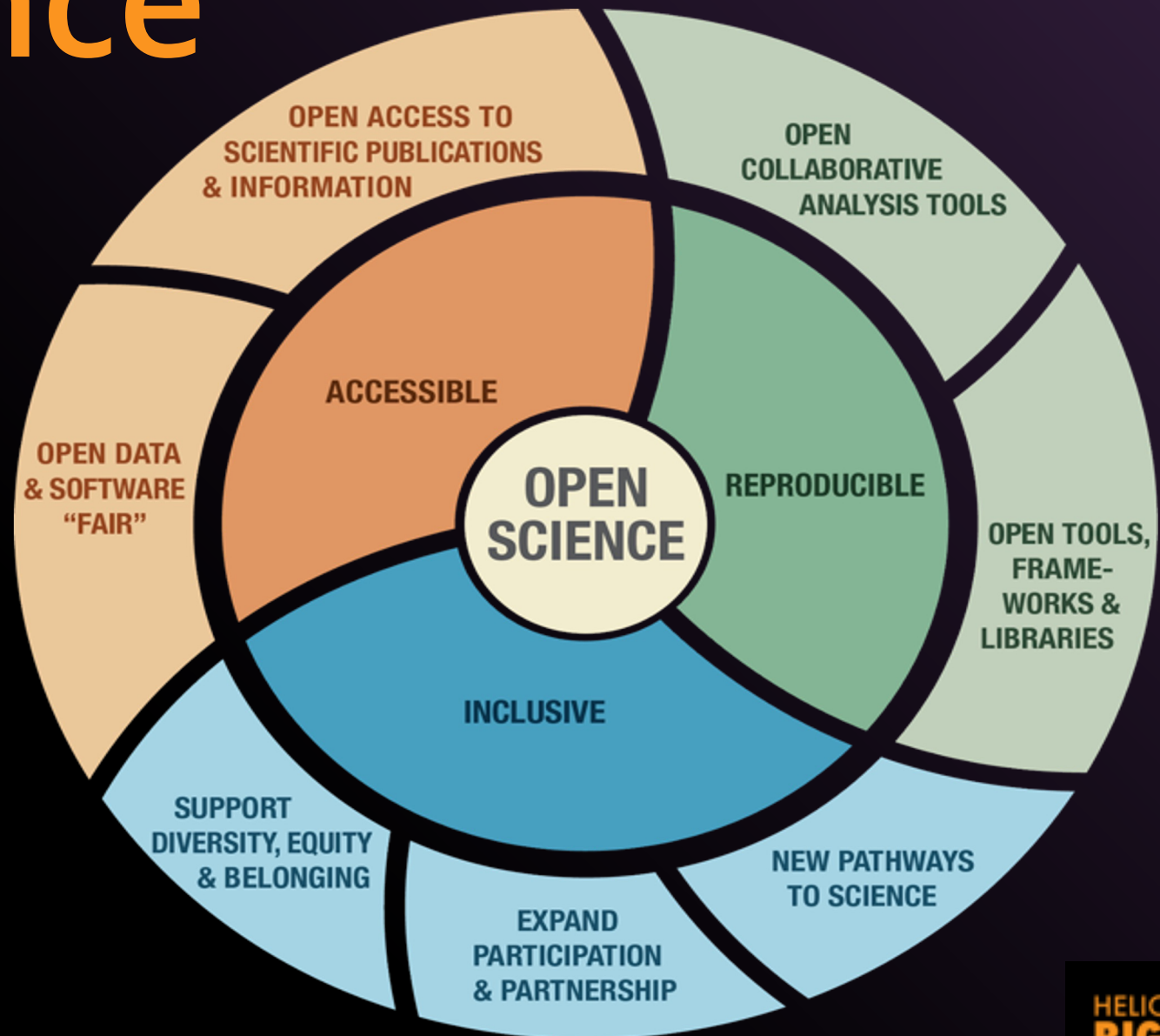


# Open Science

Accessible

Reproducible

Inclusive



# The White House announces 2023 A Year of Open Science

CDC ♦ DOA ♦ DOC ♦ DOE ♦ DOS ♦ DOT ♦ NASA ♦ NEH ♦ NIH ♦ NIST ♦ NOAA ♦ NSF ♦ SI ♦ USDA ♦ USGS

A multi-agency initiative across the US Federal government that will

- Spark change
- Inspire open science engagement
- Advance adoption of open science



<https://open.science.gov/>

HELIOPHYSICS  
BIG YEAR

# SPD-41a: SMD's updated Scientific Information Policy

- SPD-41a updates the previously released SPD-41, which consolidated existing Federal and NASA policy on sharing scientific information.
- Policy updates were developed with:
  - Science Mission Directorate (SMD) community input via workshops and RFIs
    - Input from our data repositories and missions
  - National Academies studies
  - White House OSTP Memo on Ensuring Free, Immediate, and Equitable Access to Federally Funded Research
- One component of SMD's Open-Source Science Initiative (OSSI)



<https://science.nasa.gov/researchers/science-data/science-information-policy>

HELIOPHYSICS  
BIG YEAR

# SPD-41a: Policy Updates

*forward looking and will apply to all future SMD-funded scientific activities*

## Major Policy Updates

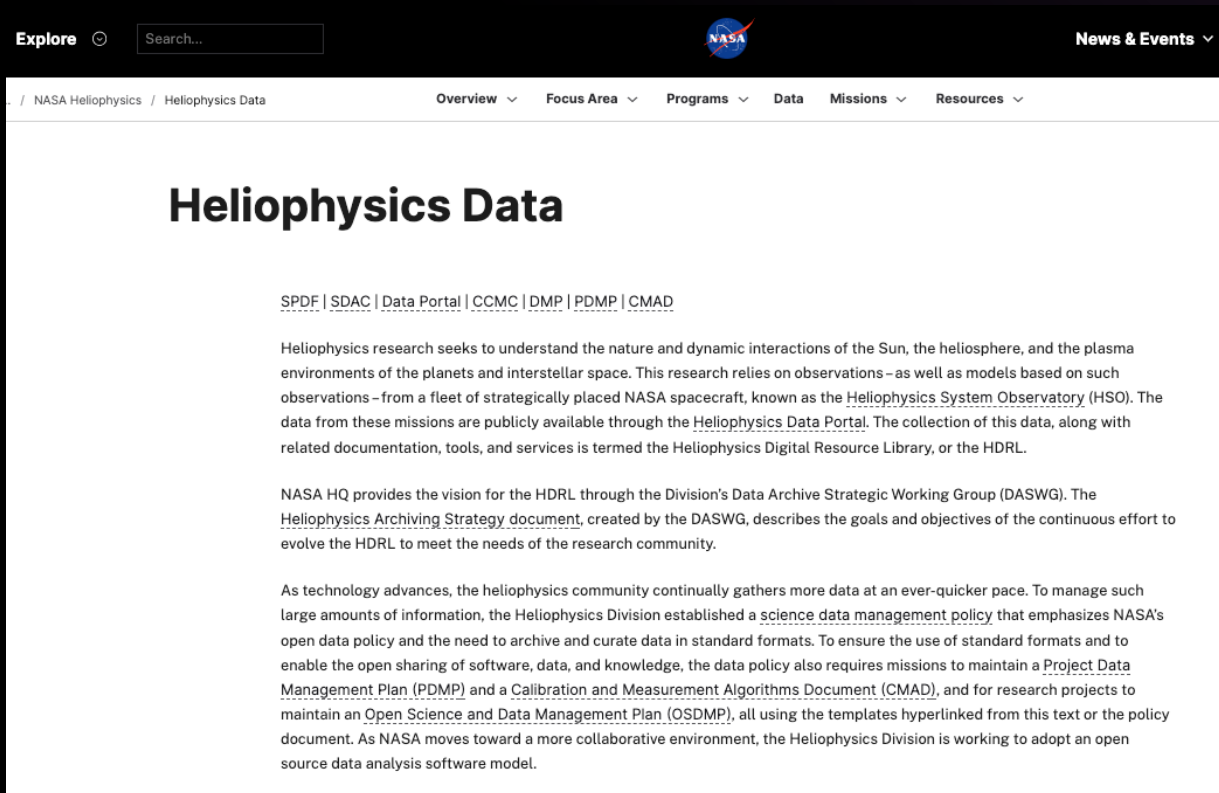
- Peer-reviewed publications are made openly available with no embargo period.
- Research data and software are shared at the time of publication or the end of the funding award.
- Mission data are released as soon as possible and unrestricted mission software is developed openly (For HPD that is 6 months.)
- Science workshops and meetings are held openly to enable broad participation.



<https://science.nasa.gov/researchers/science-data/science-information-policy>

HELIOPHYSICS  
BIG YEAR

# Where to find resources, templates, and documents



[SPDF](#) | [SDAC](#) | [Data Portal](#) | [CCMC](#) | [DMP](#) | [PDMP](#) | [CMAD](#)

Heliophysics research seeks to understand the nature and dynamic interactions of the Sun, the heliosphere, and the plasma environments of the planets and interstellar space. This research relies on observations – as well as models based on such observations – from a fleet of strategically placed NASA spacecraft, known as the [Heliophysics System Observatory](#) (HSO). The data from these missions are publicly available through the [Heliophysics Data Portal](#). The collection of this data, along with related documentation, tools, and services is termed the Heliophysics Digital Resource Library, or the HDRL.

NASA HQ provides the vision for the HDRL through the Division's Data Archive Strategic Working Group (DASWG). The [Heliophysics Archiving Strategy document](#), created by the DASWG, describes the goals and objectives of the continuous effort to evolve the HDRL to meet the needs of the research community.

As technology advances, the heliophysics community continually gathers more data at an ever-quicker pace. To manage such large amounts of information, the Heliophysics Division established a [science data management policy](#) that emphasizes NASA's open data policy and the need to archive and curate data in standard formats. To ensure the use of standard formats and to enable the open sharing of software, data, and knowledge, the data policy also requires missions to maintain a [Project Data Management Plan \(PDMP\)](#) and a [Calibration and Measurement Algorithms Document \(CMAD\)](#), and for research projects to maintain an [Open Science and Data Management Plan \(OSDMP\)](#), all using the templates hyperlinked from this text or the policy document. As NASA moves toward a more collaborative environment, the Heliophysics Division is working to adopt an open source data analysis software model.

## Heliophysics Data Webpage

- Templates for key documents such as:
  - Open Science Data Management Plan (OSDMP)
  - Project Data Management Plans (PDMP)
- Links to policies
  - Heliophysics Data Policy (further definitions and clarifications)
  - SPD-41a
- Shortcuts to Heliophysics Digital Resource Library (HDRL) repositories
  - Space Physics Data Facility (SPDF)
  - Solar Data Analysis Center (SDAC)

<https://science.nasa.gov/heliophysics/data>

HELIOPHYSICS  
BIG YEAR

# OPEN SCIENCE

1. Open Science is a journey. We hope to continuously improve!
2. Thank you for your patience! The Heliophysics Community is already doing great!
3. Please keep engaged. Your feedback and ideas are needed!

# FUTURE PRIORITIES

## 1. Outreach

- Dedicated outreach support staff
- Improved web experience across archives and services
- Workshops to engage broader community understand needs

## 2. Open Science Initiatives

- FAIR assessment of HDRL components
- Engage and lead within SMD's Open Science Initiative
- Build stronger connections with Citizen Science Initiatives

## 3. Data Discovery

- Improved data search and integration with Science Discovery Engine
- HEK full support of non-solar event data
- Enhanced Data ingest and registration
- Improvements to metadata standards