## HELIOPHYSICS DIVISION

# Heliophysics Division Science Data Management Policy

**Version 2.2**

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**Approved by:** _ Digitally signed by JOSEPH WESTLAKE Date: 2025.02.14 14:50:07 -05'00'

Joseph Westlake
Director, Heliophysics Division

National Aeronautics
and
Space Administration

NASA Headquarters
Washington, D. C.

CHECK THE HELIOPHYSICS DATA WEBSITE AT:
https://science.nasa.gov/heliophysics/data
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

# Executive Summary

Heliophysics research seeks to understand the nature and dynamical interactions of the Sun, the heliosphere, and the plasma environments of the Earth and planets based on data from the fleet of spacecraft and appropriate ground-based assets collectively termed the Heliophysics System Observatory, or HSO, in addition to data produced by research efforts.

The Heliophysics Science Data Management Policy serves to articulate the governing principles and standards of the Heliophysics Digital Resource Library (HDRL) that is the public face to access data and related documentation, tools, and services of NASA's HSO and research efforts. This policy provides a blueprint for the HDRL, tracing the data lifecycle from measurements to persistent curation and sustainment.

The data environment described here is guided by a vision provided by NASA Headquarters (HQ) with community input through the Heliophysics Division's Data Archive Strategic Working Group (DASWG). The DASWG created the *Heliophysics Archiving Strategy* document, which can be found on the Heliophysics Division website. This vision is implemented through peer-reviewed data systems driven by community needs and founded on community-based standards and openly accessible data. Consistent with this approach, data providers and data users share responsibility for the quality and proper use of the data for research.

Heliophysics data produced by space flight missions and research and analysis (R&A) activities are the core of the HDRL. The proposals for these define the science objectives that determine the required data products. The production and serving of the data from a mission or R&A activity are governed by a Project Data Management Plan (PDMP) or Open Science and Data Management Plan (OSDMP), respectively. During the active phases of a mission, data are stored and served by the HDRL, and a duplicate set may also be available through mission or instrument data centers. The HDRL is the final location for all scientific data and documentation.

The heliophysics data from missions and R&A activities are to be made available in accordance with the *Scientific Information Policy for the Science Mission Directorate*. Access can be facilitated by missions and researchers working with the HDRL to use standard formatting and hosting. The use of standards for data and metadata formats allows uniform data access through tools such as IDL, Python, MATLAB, or application interfaces that give researchers the ability to apply user- or community-developed tools for a wide array of research from single instrument to cross-mission analysis and visualization.

This data policy is vital to our research community, and it incorporates the community's continued input. This is a living document, to be modified as needed as our science program evolves. We welcome your feedback, as only through such interaction will the HDRL continue to be responsive to the community's needs.

# Change Information Page

| Change History | | |
|---|---|---|
| ***Revision*** | ***Effective Date*** | ***Description of Change*** |
| 1.0 | 6/25/07 | Baseline |
| 1.1 | 4/12/09 | Updated language from “permanent archives” to “Final archives” in a figure and text.<br>Made various text updates throughout document and appendices. |
| 1.2 | 10/4/16 | Made various text updates throughout document and appendices regarding role of archives and consolidation of Virtual Observatories. |
| 2.0 | 2/14/22 | Updated language for consistency with SPD-41 SMD Scientific Information Policy.<br>Restructured document to emphasize explicit policy statements (Section 2). |
| 2.1 | 2/14/23 | Updated language and definitions for consistency with SPD-41a SMD Scientific Information Policy.<br>Replaced Data Management Plan (DMP) requirement with Open Science and Data Management Plan (OSDMP).<br>Clarified archiving requirement for research data of scientific utility. |
| 2.2 | 2/14/2025 | Updated links to online references and resources for consistency with NASA Web Modernization activities.<br>Clarified policy applicability to scientific information. |

# Contents

# Section 1. Purpose and Scope

## 1.1 Purpose

The purpose of this document is to present the Heliophysics Science Data Management Policy, which is based on the vision and goals of the *Science Mission Directorate's (SMD) Strategy for Data Management and Computing for Groundbreaking Science* and the *Heliophysics Archiving Strategy*. This policy describes how scientific information from the science programs sponsored by NASA's Heliophysics Division (HPD) is shared, and its scope encompasses all phases of the mission, R&A, and data life cycles. It provides:

- requirements for maintaining long-term availability and accessibility [Section 2], and
- specifications for Project Data Management Plans (PDMPs), Calibration and Measurement Algorithms Documents (CMADs), and Open Science and Data Management Plans (OSDMPs) through templates released on the Heliophysics Data website.

"Exploration and scientific discovery are at the core" of NASA's SMD.[1] The Heliophysics Division links to the NASA Strategic Plan through Strategic Goal #1: Expand Human Knowledge through New Scientific Discoveries, specifically Strategic Objective 1.2.: Understand the Sun, solar system, and universe. HPD fulfills this objective through two primary annual performance goals[2]:

> *1.2.1: Demonstrate progress in exploring and advancing understanding of the physical processes and connections of the Sun, space, and planetary environments throughout the Solar System.*
>
> *1.2.6: Demonstrate progress in developing the capability to detect and knowledge to predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.*

This policy is a supplement to SMD Policy Document (SPD)-41a: *Scientific Information Policy for the Science Mission Directorate*. New missions and investigations shall follow all parts of this policy and SPD-41a. Existing missions and investigations should adopt all parts of this policy and SPD-41a consistent with available resources. This policy document will be updated on an as-needed basis.

A key step toward the goals of the HPD missions (the current collection of HPD missions being the Heliophysics System Observatory, or HSO) is the production and analysis of high-quality data from space platforms. The overall success of these research goals requires an integration of data from the many instruments and missions comprising the HSO as well as complementary sources of data used to perform heliophysics research (such as data produced from R&A activities and data from non-NASA sources).

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[1] *Science 2020-2024: A Vision for Scientific Excellence*. https://explorers.larc.nasa.gov/2023ESE/pdf_files/2020-2024%20Science.pdf

[2] Reference the current FY Volume of Integrated Performance. https://www.nasa.gov/ocfo/performance-report/

Two overarching principles essential to achieving the goals of current HPD programs are:

1. Implementing NASA's open data policy of making high-quality, high spatial and temporal resolution data publicly available as soon as practical, and
2. Adhering to the goal of early and continuing scientific data usability, which requires uniform descriptions of high-quality data products, adequate documentation, sustainable and open data formats, easy electronic access, appropriate analysis tools, and care in data preservation.

This paradigm involves the data users from the general science community as responsible partners in the improvement of the data environment and of the data products themselves.

## 1.2 Scope

This policy applies to all HPD-funded activities regardless of the funding vehicle. This shall include:

1. **Mission Information**: Mission information comprises scientific information produced by NASA HPD missions. Missions include strategic or flagship missions and investigations selected under Announcements of Opportunity (AOs), including those selected under the Stand-Alone Missions of Opportunity Notice (SALMON) and Cooperative Agreement Notices (CANs).
2. **Research Information**: Research information comprises scientific information produced by investigations funded via research awards. This includes funding from investigations selected under NASA Research Announcements (NRAs), including those selected under the Research Opportunities in Space and Earth Science (ROSES) NRAs.
    a. This also includes investigations funded via research sub-awards for research made as part of Mission-funded activities or cooperative agreements.
    b. Research awards can include grants, cooperative agreements, contracts, task orders, interagency transfers, direct internal NASA funding, and other applicable funding vehicles.
        i. This also includes information produced by other HPD-funded activities such as, but not limited to, experiments, investigations using small sats/CubeSats or sub-orbital platforms, field campaigns, or citizen science projects.

    *Note that the ROSES Heliophysics Data Environment Enhancements (HDEE) program explicitly allows for projects dedicated to making previously unavailable, HPD-relevant NASA and non-NASA data usable and available through the HDRL.*

## 1.3 Definitions

Per SPD-41a, key terms in this policy are defined as follows:

- Data: Scientific or technically relevant information that can be stored digitally and accessed electronically. This includes:
    - Information produced by missions include observations, calibrations, coefficients, documentation, algorithms, and any ancillary information.

    - Information needed to validate the scientific conclusions of peer-reviewed publications. This includes data underlying figures, maps, and tables.
    - This does not include laboratory notebooks, preliminary analyses, drafts of scientific papers, plans for future research, peer review reports, communications with colleagues, or physical objects, such as laboratory specimens.

- Publication: Documents released through print, electronic, or alternative media. This includes peer reviewed manuscripts, technical reports, conference materials, and books. This does not include laboratory notebooks, preliminary analyses, drafts of scientific papers or preprints, plans for future research, peer review reports, or communications with colleagues.
- Report: Documents produced through print, electronic, or alternative media containing Scientific and Technical information. These documents are usually not peer reviewed. This includes Technical Publication, Technical Memorandum, Contractor Report, Conference Publication, Special Publication, and Technical Translation. This does not include interim research Grant Reports.
- Scientific Information: Scientific knowledge produced as part of a research activity. This can include, but is not limited to, publications, data, and software.
- Scientific Software: Software that provides users some degree of scientific utility or produces a scientific result or service.
- Scientific Utility: Information that is necessary to validate research findings or beneficial for future research activities.
- Software: computer programs in both source and object code that provide users some degree of utility or produce a result or service.
- Source code: Human-readable set of statements written in a programming language that together compose software. Programmers write software in source code, often saved as a text file on a computer. The terms code and source code are often used interchangeably.

# Section 2. Heliophysics Data Policies

The policies governing the production, distribution, and storage of heliophysics data and related artifacts were developed in alignment with the data management principles and policies of the Science Mission Directorate. In this policy document, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended but not required, "will" denotes expected outcome, and "are" or "is" denote descriptive material.

1. **The HDRL shall commit to the full and open sharing of heliophysics data obtained from NASA HPD-sponsored programs (e.g., observing satellites, sub-orbital platforms, field campaigns, and research) with all users (i.e., the scientific community) as soon as such data become available.**
    a. **A period not longer than six months after mission data have been obtained may be allowed for activities such as initial calibration and validation of the data per the current SMD standard prior to the data reaching the HDRL. This period will be as short as possible, with standard HPD practice typically being one month for mission data to be obtained and delivered to the HDRL.**
    b. **Heliophysics research data shall become publicly available no later than the publication of the peer-reviewed article that describes it is published, or at the conclusion of the research award, scientifically useful data and advanced data products associated with the award that have not already been made public shall be made publicly available.**
    c. **Data collected as part of HPD crowdsourcing projects or citizen science projects shall be made public.[3]**

*Timely availability of data is essential to maximizing its utility and value. Beyond the mission responsible for collecting it, timely science data and its associated metadata are necessary for the validation, calibration, and use of models by not just the heliophysics community but also other groups and stakeholders with a need for space weather forecasting (e.g., human space flight).*

2. **The HDRL and any HPD-funded missions and R&A activities will plan and follow data acquisition policies that ensure the collection and usability of long-term data sets needed to satisfy the research requirements of NASA's Heliophysics Division.**
    a. **HDRL shall make available all NASA-generated HPD mission data products along with any calibrations, coefficients, algorithms, documentation, and ancillary data used to generate these products.**
        i. **The full science potential data of a mission, not irreversibly transformed, or the raw data, shall be archived along with tools for its reduction to science products and documented algorithms for this**

[3] American Innovation and Competitiveness Act

**process. Relevant engineering and "housekeeping" data should also be preserved.**

b. **HPD-funded R&A activities shall identify and archive information of scientific utility. For HPD, scientific utility refers to any new data or products, to include final simulation results, that are necessary to reproduce results. This includes the data used to create tables, graphs, or figures from publications.**
c. **The HDRL shall make available all NASA-generated HPD R&A data products along with algorithms, documentation, and ancillary data used to generate these products.**
d. **Heliophysics data shall be made available in convenient, modifiable, and open formats. Processed data shall be stored in one of the standard self-describing science data formats accepted by the HDRL. [4]**
e. **Heliophysics data shall follow the FAIR Guiding Principles for scientific data management and stewardship. This means data should be findable, accessible, interoperable, and reusable (FAIR). [5]**
f. **Data providers shall work with the Space Physics Archive Search and Extract (SPASE) Metadata Working Team (SMWT) in creating SPASE records for the data collections. The SPASE records are used to populate the HDRL as a discipline-wide data registry and will be used to create Digital Object Identifiers (DOIs) for the data collections, that can be cited in science papers.[6]**
g. **Heliophysics data shall be reusable with a clear, open, and accessible data license (e.g., Creative Commons license). If there are no other restrictions on the data, the data shall be released with a Creative Commons Zero license.**
h. **The HDRL shall ensure that all heliophysics data are citable using a persistent identifier, generally through the SPASE registries or DOIs. Data users are strongly encouraged to cite the sources of the information used to conduct their peer-reviewed, published research using these identifiers.**
i. **HPD-funded software shall be released under a permissive license that has broad acceptance in the community and shall be made available in a publicly accessible repository that is widely recognized by the community.[7] If**

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[4] https://spdf.gsfc.nasa.gov/guidelines/archive_newdata_reqt.html

[5] Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci. Data 3:160018 doi: 10.1038/sdata.2016.18 (2016).

[6] The SPASE Data Model: A Metadata Standard for Registering, Finding, Accessing, and Using Heliophysics Data Obtained From Observations and Modeling. Roberts, D. A., Thieman, J., Génot, V., King, T., Gangloff, M., Perry, C., … Hess, S. (2018). *Space Weather*, 16(12), 1899–1911. https://doi.org/10.1029/2018SW002038

[7] *Open Source Software Policy Options for NASA Earth and Space Sciences*. https://nap.nationalacademies.org/catalog/25217/open-source-software-policy-options-for-nasa-earth-and-space-sciences

**commercial software is used, then the HPD-funded source code shall be released and made available.**

j. **All publications arising from HPD-supported investigations shall be made publicly accessible. An openly accessible version of the as-accepted, peer-reviewed manuscripts shall be available via a NASA-designated repository no-later than 12 months after publication.[8] Publishing the manuscript as Open Access and posting a version on a community recognized preprint server are encouraged.**

*The most important "standard" for the HDRL is a standard of behavior, namely, the acceptance of the need for open, independently usable data. A standard infrastructure—with uniformity of product documentation, formats, and access methods—allows scientists to access data from many missions from one web location or service. The use of internet-based services founded on community-evolved practices and standards allows for implementation of specific, peer-reviewed services that fulfill the vision defined by NASA HPD and informed with community input. The NASA HDRL and international partners have formed the International Heliophysics Data Environment Alliance[9] (IHDEA) to extend the use of standards and to maximize the sharing of data and other resources.*

3. **The HDRL will collect a variety of metrics to assess the efficacy of its data systems, its services, and user satisfaction. Consistent with applicable laws, HPD will make these metrics data available for review.**

*To ensure responsiveness to the community and that the community has access to a state-of-the-art digital library, the HDRL should obtain, review, and—when necessary— act on user feedback to address user needs.*

4. **The HDRL will enforce a principle of uniform data access for all users. For data products supplied from an international partner or another agency, the HDRL will restrict access only to the extent required by the appropriate agreements.**

*Availability and sharing of data are essential to evolving the wider community's fundamental understanding of the Sun and its effects. Additionally, NASA has a long-standing culture of promoting the full and open sharing of data with research communities, private industry, academia, and the public.*

5. **All NASA HPD missions, projects, and grants and cooperative agreements shall document their implementation of these data management policies.**
    a. **Missions shall generate a Project Data Management Plan (PDMP) that describes how data will be generated, processed, distributed, analyzed, and archived based on the PDMP template.**

[8] Further guidance on how to make the publication publicly accessible will be available via the Scientific and Technical Information (STI) website (https://www.sti.nasa.gov/).
[9] https://ihdea.net/

b. **PI-led missions shall generate a Calibration and Measurement Algorithm Document (CMAD) for the mission while directed missions shall generate a CMAD for each instrument. The CMAD provides a detailed description for processing the telemetry into scientifically-useful quantities in geophysical units, including calibrations, error analysis, and documentation of issues and instrument changes based on the CMAD template.**
c. **Baselined (signed) PDMPs and CMADs, as well as any updates, shall be distributed to applicable HPD Data Facilities or Centers and be accessible by the public via the HDRL.**
d. **Research projects shall generate an Open Science and Data Management Plan (OSDMP) based on the ROSES OSDMP Template.**

*The mission's PDMP captures the architecture and implementation of the processing and distribution of mission data. As this content is similar to that of a Science Data Management Plan, a requirement from NPR 7120.5 NASA Space Flight Program and Project Management Requirements, in some cases a mission may choose to use the PDMP template for the Science Data Management Plan. A baselined PDMP or OSDMP will help ensure that the scientific data is standardized and organized in accordance with this Heliophysics Science Data Management Policy, enabling long-term accessibility and utility for the wider heliophysics community. Archives will use the PDMP or OSDMP to help inform infrastructure and resource utilization and planning. The CMAD identifies sources of input, provides the physical theory and mathematical background underlying the use of those inputs to retrieve data products, and describes what has been accounted for during algorithm development.*

# Appendix A. Abbreviations and Acronyms

| ACRONYM | DEFINITION |
|---|---|
| AO | Announcement of Opportunity |
| CAN | Cooperative Agreement Notice |
| CMAD | Calibration and Measurement Algorithm Document |
| DASWG | Data Archive Strategic Working Group |
| DOI | Digital Object Identifier |
| FAIR | Findable, Accessible, Interoperable, And Reusable |
| FITS | Flexible Image Transport System |
| HDEE | Heliophysics Data Environment Enhancements |
| HDRL | Heliophysics Digital Resource Library |
| HPD | Heliophysics Division |
| HQ | Headquarters |
| HSO | Heliophysics System Observatory |
| IDL | Interactive Data Language |
| IHDEA | International Heliophysics Data Environment Alliance |
| ISTP | International Solar-Terrestrial Physics |
| NASA | National Aeronautics and Space Administration |
| NetCDF | Network Common Data Format |
| NPR | NASA Procedural Requirement |
| NRA | NASA Research Announcement |
| OSDMP | Open Science and Data Management Plan |
| PDMP | Project Data Management Plan |
| R&A | Research and Analysis |
| ROSES | Research Opportunities in Space and Earth Science |
| SALMON | Stand-Alone Missions of Opportunity Notice |
| SMD | Science Mission Directorate |
| SMWT | SPASE Metadata Working Team |
| SPASE | Space Physics Archive Search and Extract |
| SPD | SMD Policy Document |