NASA's Heliophysics Digital Resource Library (HDRL)

Supporting the Heliophysics Research Community

The Heliophysics Digital Resource Library (HDRL) provides open-access gateways to thousands of datasets from current and historic NASA Heliophysics missions while enabling sophisticated cross-mission analysis and observation-model comparison. HDRL embraces NASA's commitment to an inclusive, open science community and has adopted community standards, such as SPASE and the ISTP metadata guidelines, to unify heliophysics datasets, analysis tools, and other resources with consistent descriptions for easy access. This massive data repository supports researchers in their quests to unlock groundbreaking scientific discoveries about the nature of the relationship between the Sun, planets, asteroids, comets, and space environment as a dynamic system.

HDRL MEMBERS

Solar Data Analysis Center (SDAC)

The Solar Data Analysis Center (SDAC) supports the analysis of solar physics data. The SDAC stores and provides data from NASA's solar physics missions. The bulk of these data are captured using remote-sensing instruments, which observe processes within the Sun's layers and track activity as it expands into the heliosphere. These data help us understand the physics of the Sun and help predict the Sun's effects on Earth and our atmosphere. SDAC supports visualization tools (including Helioviewer), the SolarSoft software library used for data analysis, and the Virtual Solar Observatory (VSO) discovery service to search and download solar physics data products from around the world.

Space Physics Data Facility (SPDF)

The Space Physics Data Facility is NASA's archive for non-solar heliophysics data, often called space physics data, from heliophysics missions. These data are retrieved from in situ measurements of plasma, energetic particles, magnetic and electric fields, and radio and plasma waves in the interplanetary space and the space environment of Earth and other planets. The space physics investigations aim to better understand how the solar phenomena and resultant space weather impact space environments of Earth and other objects in the solar system. SPDF maintains the CDAWeb data explorer and plotting system, the SSCWeb database of spacecraft trajectories with 4D orbit viewer capabilities, the OMNIWeb database that includes solar wind data at Earth's bow shock nose and other locations of the heliosphere, and the Common Data Format (CDF) self-describing science data format and associated software.

Heliophysics Data and Model Consortium (HDMC)

HDMC supports the development of software and services to help promote greater synergy between SDAC, SPDF and the larger heliophysics community. This entity serves as a catalyst for carrying out HDRL's mission to yield the greatest value of research from NASA's heliophysics missions. HDMC supports initiatives in open science and community outreach while HDMC grants include support for collaborators such as PyHC, SPEDAS, Autoplot, and HelioCloud. HDMC also provides support for heliophysics data standards, registration, and discovery of overall HDRL resources.

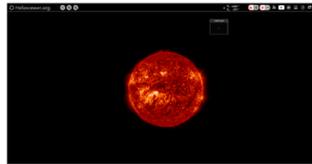## FEATURED TOOLS

Heliophysics Data Portal

The Heliophysics Data Portal is a one-stop shop to browse a comprehensive list of all of NASA's heliophysics missions data resources, as registered in the SPASE format. Users can search for datasets using any combination of time, observatory, measurement type, instrument, observed region, spectral range, and keywords. After identifying the dataset you want, you can follow access links to NASA archives and other institutions that host the datasets you need. Dataset DOIs are

Helioviewer

Helioviewer is a web-based data visualization tool supported by NASA's Solar Data Analysis Center. It's like using a map app on the Sun! Users select spacecraft instruments to view images of the Sun, overlay features and events, and make screenshots and movies of solar phenomena. This tool supports exploratory data analysis and enables researchers to discover, pinpoint, and monitor solar events. A downloadable version called JHelioviewer with 3D streaming capability is available.

4-D Orbit Viewer – New Web-Based Version!
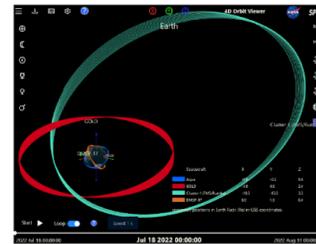
This prototype interactive 4D Orbit Viewer supported by NASA's Space Physics Data Facility showcases the locations and orbits of over 100 spacecraft and planets as 3-D animations, with time added as a 4th dimension. Currently available trajectories include the four inner planets (Mercury, Venus, Earth, and Mars), the Sun, and the

listed along with the datasets for citing in your papers.

Moon. Data and plots can be downloaded through the viewer. This prototype browser-based tool will replace the [original Java-based tool]. Orbits and trajectories in heliocentric coordinates and other planetary coordinates are planned to be added to the new orbit viewer.

HelioCloud

HelioCloud is a time-saving, cloud-based tool for heliophysics researchers to rapidly access and analyze high-volume datasets from a web browser. With an easy-to-navigate interface and generous data storage, HelioCloud offers a streamlined approach for conducting research. An open science framework breaks down barriers to collaboration by enabling multipoint access to shared data, code, and analysis tools in a secure environment. This community-based project invites new users and developers to take part in the game-changing evolution of big data analysis.

SolarSoft

Solarsoft is an analysis and processing environment for solar physics data. Based on the IDL programming language, it contains many algorithms used and supplied by mission and instrument teams for the calibration and creation of higher level data products.

SunPy Project

The SunPy Project supports an ecosystem of free and open-source Python packages for solar physics data analysis. SunPy enables users to search and download from various data sources, analyze time series and image data from different observatories in a consistent interface, and transform data between coordinate systems when combining data from multiple spacecraft.

SPEDAS

Space Physics Environment Data Analysis Software (SPEDAS) is a publicly shared data analysis library written in the IDL programming language. The framework supports loading, plotting, analysis, and visualization from a number of space- and ground-based observatories. pySPEDAS is an alternative version of the framework written in Python.

Heliophysics Events Knowledgebase (HEK)
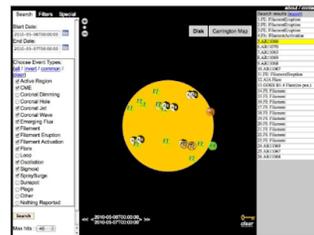
The Heliophysics Events Knowledgebase (HEK) is a catalog of events and features found to have occurred on the Sun, including solar flares, filaments, coronal mass ejections, and active regions. Researchers can use the iSolSearch tool to search and identify events by time, location, event type, mission, and instrument. HEK enables scientists to more efficiently find information relevant to their research without having to download and sift through terabytes of data.

Space Physics Archive Search & Extract (SPASE) Registry

The SPASE is an international community of scientists, specialists, information engineers, and system designers who endeavor to create standards and services that enable the open exchange of heliophysics data. As part of NASA's new data requirement for all NASA-sponsored heliophysics projects, HDRL uses the SPASE standard to register datasets from NASA heliophysics missions, and creates DOIs for direct public reference.