Committee on Space Research (COSPAR)

THE HELIOPHYSICS GUIDELINES

A COMMON VISION FOR THE SCIENTIFIC DISCIPLINE OF HELIOPHYSICS

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Recognizing that all of humanity lives on the same planet, under the same star, the Sun, and **underscoring** the importance of cooperation and the open sharing of scientific results and data for Heliophysics research;

Noting that a new scientific discipline, "Heliophysics", has evolved to meet the challenges posed by our technological society living with a volatile star, and has unified the distinct scientific disciplines of solar physics, space plasma physics, and aeronomy under a common umbrella of scientific inquiry;

Ushering in a new era of Heliophysics research that leverages advancements in space accessibility, commercial capabilities, artificial intelligence/machine learning (AI/ML), and that addresses societal needs of an advancing technological society;

Building upon almost 70 years of space-based Heliophysics research, that began with the launch of humanity's first satellites, that discovered Earth was surrounded by radiation belts;

Considering that the science of Heliophysics is cross-disciplinary and involves the study of complex systems-of-systems, and requires multipoint, heterogenous constellations of space- and ground-based measurements, and advanced numerical simulations, all built upon open data, open science, and unified data standards;

Acknowledging that the influences of the Sun through Space Weather impacts all of humanity, both at home on Earth and during humanity's journey of exploration through the Solar System, including the continuous human presence in low-Earth orbit, and expanding to the Moon, Mars, and throughout the Solar System;

Affirming that Heliophysics has always been an international endeavor, with examples going back to the International Geophysical Year (IGY), extending through the International Solar Terrestrial Physics (ISTP) Program which was endorsed by the Inter-Agency Consultative Group (IACG), and exemplified most recently by the International Living With a Star (ILWS) program and the newly created WMO-COSPAR-SES working group, defined by the Coimbra Declaration, formed to improve the global coordination of space weather activities;

Further affirming the value of international scientific collaboration that forges bonds between nations and opens dialogue between peoples;

Desiring to establish a common worldwide Heliophysics discipline, centered on the study of the Sun and its interaction with Earth and other solar system bodies, with coordination of ground- and space-based assets, and universal community best practices including open data, open science, and unified data standards;

Therefore, COSPAR maintains and promulgates these Guidelines on Heliophysics:

Section 1 - Purpose

The purpose of these Guidelines is to promote a common vision for the new scientific domain of Heliophysics, the study of the Sun and its effects through the solar system, via a practical set of non-legally binding guidelines and best practices to enhance and enable scientific discovery while also advancing understanding of variability in space (Space Weather), the applied aspect of Heliophysics, to guide system design and mitigate its impacts.

Scientific studies of the Sun and its interactions with Earth and Solar System bodies predate the space age. With the launch of Sputnik 2 and Explorer I, which both discovered the radiation belts, humanity began to explore space with in situ and remote instrumentation and at electromagnetic wavelengths otherwise shielded by Earth's protective atmosphere. Over the ensuing decades, humanity has explored the furthest reaches of the Solar System, established a continual human presence in space, and has come to rely on space for critical elements of our society. Heliophysics has expanded into the study of both fundamental plasma physics in the natural plasma laboratory of humanity's cosmic backyard and the space weather that impacts society. Heliophysics research and model development underpins the protection of vital technological infrastructure and humanity's journey into space.

Humanity's ever-increasing understanding of the Sun-Heliosphere system led to the unification of solar physics, space physics, and aeronomy, into a new scientific domain called Heliophysics. Heliophysics, the study of the Sun and its effects throughout the Solar System, is a recognition of the cross-disciplinary nature of the subject, and the inherent need to bring disparate skillsets together under a common theme. Space plasma physics, the science of how ionized and partially ionized plasmas behave in the presence of electromagnetic fields, is the foundational scientific discipline that undergirds the field.

Notably, the core disciplines of Heliophysics connect strongly with Astrophysics, Planetary science, and Earth science:

- *Solar physics* synergizes with astrospheres and exoplanet systems, solar-stellar comparisons, eruptive events on other stars, and laboratory astrophysics;
- *Heliospheric physics* investigates the life cycle of the solar plasmas and magnetic fields, and interplanetary dust that permeate the solar system, and their interface with interstellar space;
- *Magnetospheric physics* synergizes with star-exoplanet interactions, the comparative physics of driving by solar outflows on solar system bodies;
- *Aeronomy* and *ionosphere-thermosphere-mesosphere (ITM) physics* studies the interface of planetary atmospheres (Earth and Planetary science) with space;
- Finally, *space plasma physics* synergizes with lab plasmas and fusion devices and leverages our local cosmic plasma laboratory for fundamental plasma physics studies.

Space Weather, the applied science of Heliophysics, addresses the impact of the dynamic nature of the Sun on humans, society, exploration, technologies, and critical infrastructure in space and on surfaces of solar system bodies.

Humanity has extended from the physical domain of our birthplace, Earth, to the neighboring domain of the Heliosphere, carved out by the ever-flowing solar wind. Space-based infrastructure has grown explosively in the past half-century, such that space is increasingly crowded, and subject to highly variable space weather impacts. Furthermore, humans have been living continuously in space for the past three decades, and plan a sustained presence throughout the Heliosphere, including on the Moon and at Mars. Now that humanity has moved from Earth into the physical domain of the Heliosphere, the requirements on its study have changed to the point that we need to understand the inherent connectivity of the systems. In this sense, Heliophysics is truly a new science domain, unifying a wide array of scientific disciplines and expertise under a common science theme. Humanity is no longer simply observing some remote cosmic realm; a new level of understanding is required to develop and inhabit this harsh new environment. Such a large effort calls for a coordinated scientific discipline and scientific program, if humanity is to continue to progress from the domain of our birth, Earth, to the domain of the stars.

To fully realize the potential of Heliophysics as a driving force for scientific discovery and societal benefit, a clear understanding of its fundamental principles is essential. These principles are outlined below:

1. In the same way that astrophysics is the science of the domain of the stars, Heliophysics is the science of the domain of the Sun.
2. The domain of the Sun includes the Heliosphere and all solar system objects, including the Sun and Earth.
3. Within this domain, Heliophysics is a science of connections of systems-of-systems, including the Sun and extended solar atmosphere, planetary ionosphere-thermosphere-mesosphere systems, planetary magnetospheres, and the interplanetary space that connects these systems.
4. Heliophysics requires inherently multi-disciplinary skill sets and includes components of solar and space physics, aeronomy, ionosphere-thermosphere-mesosphere (ITM) physics, magnetospheric physics, and planetary physics, among others.
5. The disciplines that comprise Heliophysics often sit at the boundaries of Earth Science, through atmospheres and ionospheres, Planetary Science, with magnetospheres and exospheres, and Astrophysics, including stellar activity and exo-planetary habitability. These boundaries are not sharply defined, but point to the cross-disciplinary nature of Heliophysics. Heliophysics also links to Biological Science via space weather impact on humans.
6. The physics of ionized and partially ionized plasmas, including dusty plasmas, is common across these components.

Section 2 - Definitions

"Heliophysics" is defined as the study of the Sun and its effects throughout the Solar System;

and

"Space Weather" is defined as applied research on the dynamic, highly variable conditions of the space environment, including the Sun, its effects on society and its extensions within the Solar System, and on human biology.

Section 3 - Open Heliophysics

1. These Guidelines encourage open sharing, widespread dissemination, sustained archiving, and discoverability of Heliophysics-related scientific data, making the observational data and scientific results obtained available to the public and the international scientific community, as appropriate, in a timely manner. These include, but are not limited to, near real-time data, data from ground-based instrumentation such as telescopes and radio arrays, magnetometers and ionospheric radars, riometers, and all-sky imagers, and in-situ and remote space-based data measurements.
2. These Guidelines endeavor to expand access to open data, Heliophysics datasets should be archived for current and future generations, and ideally contain sufficient documentation to enable researchers to understand the technique(s) used to produce the data, which may include instrument description and data processing documentation, sufficient to enable determination of the accuracy, precision, uncertainties, and reliability of said data. Subject to national and international intellectual property rules, non-restricted scientific software should be similarly archived and made openly available.
3. These Guidelines intend to encourage use of existing universal data and software standards, where needed and appropriate, and to develop new universal standards in collaboration with the Heliophysics community, National Space Agencies, or international organizations, such as the International Organization for Standardization (ISO) or COSPAR, as appropriate.

Section 4 - Implementation

1. These Guidelines encourage the best practices of coordinating:
    a. Heliophysics-related sciences; and
    b. Efforts to address the challenge of making heliophysics research useful for space weather operations and applications. This would include addressing transitioning heliophysics research to operations/applications, distinguishing between the research and operations/applications, and encouraging the current and future generation of heliophysicists to invest in and develop these capabilities.
2. Coordination of best practices include sharing agency plans, identifying research and measurement gaps, resolving overlapping efforts, considering suborbital, ground-based, and space-based collaborative opportunities, considering recognition of the elements of the Guidelines, and periodically assessing the elements of the Guidelines.
3. Coordination of best practices would also include Space Weather discussions within existing operational Space Weather coordination entities including, but not limited to, the World Meteorological Organization (WMO), Coordination Group for Meteorological Satellites (CGMS), and the International Civil Aviation Organization (ICAO).

Section 5 - Conclusion

COSPAR is to maintain the original text of these Guidelines.

Published on 4 November 2025 in the English language.

As of 27 November 2025 the following space agencies and organisations have endorsed the Heliophysics Guidelines:

- National Space Science Center of the Chinese Academy of Sciences (NSSC-CAS)
- Solar Physics Division of the American Astronomical Society (SPD-AAS)
- the Space Studies Board of the National Academies of Sciences, Engineering, and Medicine (NASEM-SSB)
- the Space Physics and Aeronomy Section of the American Geophysical Union (SPA-AGU)

- Cyprus Space Exploration Organization (CSEO)
- Istituto Nazionale di Astrofisica (INAF)
- Canadian Space Agency/Agence spatiale canadienne (ASC-CSA)