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Space environment (natural and artificial) — Space weather information for use in space systems operations

~~1~~ Table of Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes the dynamic variability of the environment, i.e., space weather, and identifies the tools and parameters needed for space systems operations. This document is important for satellite operators who are not familiar with space weather. For example, when Satellite operators arrive on shift, they are often briefed about terrestrial weather, geomagnetic storms, and collision reports. This provides insight into any possible collisions that their system can have with debris or other satellites. In addition, others who participate in space systems operations ~~are able to~~ can benefit from this document. For example, designers, manufacturers, and launchers of space systems require real-time, operational space weather parameters that can be measured, monitored, or built into automated systems. Users of these systems include developers of software systems that provide LEO satellite orbit determination, radio communication availability for scintillation events (GEO-to-ground L- and UHF-bands), GPS uncertainties, and the radiation environment from ground-to-space for commercial space tourism. These groups require recent historical data, current epoch specification, and forecast of space weather phenomena for their automated or manual systems. National government agencies often rely on space weather data ~~that is~~ provided by their national organizations, such as those represented in the International Space Environment Service (ISES) group of 14 national agencies, and this document identifies key descriptors provided by those agencies.

This document identifies the phenomena of space weather as a dynamic component of the space environment that affects the technology of space systems. [Annexes A and B describe expanded material including guidelines on how to use the document, how to obtain specific space weather parameters, and short but detailed descriptions of parameters. Annexes A and B enable easy updates for this document because new advances in scientific and engineering understanding provide new tools for characterizing the domain of space weather. Table 1 gives an overview of existing ISO documents related to the space environment.](#)

Table 1 — Terrestrial and lunar environment documents

	LEO	PEO	MEO	GEO	>GEO
Testing/analysis/framework	ISO 15856, ISO 17851, ISO 21980, ISO/TS 22295, (AUL)	ISO 15856, ISO 17851, ISO 21980, ISO/TS 22295, (AUL)	ISO 15856, ISO 17851, ISO/TS 22295, (AUL)	ISO 15856, ISO 17851, ISO/TS 22295, (AUL)	ISO 15856, ISO 17851, (AUL)
Cosmic rays	ISO 15390, ISO 17520, ISO/TR 23689	ISO 15390, ISO 17520, ISO/TR 23689	ISO 15390, ISO 17520, ISO/TR 23689	ISO 15390, ISO 17520, ISO/TR 23689	ISO 15390, ISO 17520, ISO/TR 23689
Solar photons	ISO 21348, ISO/TR 23689	ISO 21348, ISO/TR 23689	ISO 21348, ISO/TR 23689	ISO 21348, ISO/TR 23689	ISO 21348, ISO/TR 23689
Solar particles	ISO 16698, ISO 17520, ISO/TR 18147, (solar wind), ISO/TR 23689	ISO 16698, ISO 17520, ISO/TR 18147, (solar wind), ISO/TR 23689	ISO 16698, ISO 17520, ISO/TR 18147, (solar wind), ISO/TR 23689	ISO 12208, ISO 16698, ISO 17520, ISO/TR 18147, (solar wind), ISO/TR 23689	ISO 16698, ISO 17520, ISO/TR 18147, (solar wind), ISO/TR 23689
Solar fields	ISO 16689, (solar wind), ISO/TR 23689	ISO 16689, (solar wind), ISO/TR 23689	ISO 16689, (solar wind), ISO/TR 23689	ISO 16689, (solar wind), ISO/TR 23689	ISO 16689, (solar wind), ISO/TR 23689
Main magnetic field	ISO 16695, ISO 16698, ISO/TR 23689	ISO 16695, ISO 16698, ISO/TR 23689	ISO 16695, ISO 16698, ISO/TR 23689	ISO 16695, ISO 16698, ISO/TR 23689	ISO 16695, ISO 16698, ISO/TR 23689
Magnetosphere	ISO 16695, ISO 16698,	ISO 16695, ISO 16698,	ISO 16695, ISO 16698,	ISO 12208, ISO 16695,	ISO 16695, ISO 16698,

ISO/DTR 23689:(en)

	<u>LEO</u>	<u>PEO</u>	<u>MEO</u>	<u>GEO</u>	<u>>GEO</u>
	ISO 19923 , ISO/TR 23689 , (PC-index)	ISO 19923 , ISO/TR 23689	ISO 22009 , ISO 19923 , ISO/TR 23689	ISO 16698 , ISO 22009 , ISO 19923 , ISO/TR 23689	ISO 22009 , ISO 19923 , ISO/TR 23689
Radiation belts	ISO 17761 , ISO 17520 , ISO/TS 21979 , (IRENE, internal charge), ISO/TR 23689	ISO 17761 , ISO 17520 , ISO/TS 21979 , (IRENE, internal charge), ISO/TR 23689	ISO 17520 , ISO/TS 21979 , (IRENE, internal charge), ISO/TR 23689	ISO 17520 , ISO/TS 21979 , (IRENE, internal charge), ISO/TR 23689	ISO 17520 , ISO/TS 21979 , (IRENE, internal charge), ISO/TR 23689
Plasmasphere	ISO 16457 , ISO/TR 23689	ISO 16457 , ISO 19923 , ISO/TR 23689	ISO 16457 , ISO 19923 , ISO/TR 23689	ISO 16457 , ISO 19923 , ISO/TR 23689	ISO 16457 , ISO 19923 , ISO/TR 23689
Ionosphere	ISO 16457 , ISO 16698 , ISO/TR 23689	ISO 16457 , ISO 16698 , ISO/TR 23689	(topside)	-	-
Neutral atmosphere	ISO 14222 , ISO/TR 11225 , ISO 16698 , (AO, satellite drag), ISO/TR 23689	ISO 14222 , ISO/TR 11225 , ISO 16698 , (AO, satellite drag), ISO/TR 23689	(He, H)	(He, H)	(He, H)
Micrometeoroids	ISO 14200	ISO 14200	ISO 14200	ISO 14200	ISO 14200
Debris	ISO 14200 , (radiation debris)	ISO 14200 , (radiation debris)	ISO 14200	ISO 14200	ISO 14200
Lunar	-	-	-	-	ISO 10788

Key

AUL application utility level

IRENE International Radiation Environment Near Earth

AO atomic oxygen

[ISO/DTR 23689](#)

<http://www.iso.org/ai/catalog/standards/iso/4e87fb3e-c6e5-4b84-81e0-6d2a2ae1a6a5/iso-dtr-23689>

Space environment (natural and artificial) — Space weather information for use in space systems operations

1 Scope

This document contains internationally accepted descriptions of the main phenomena of space weather, including its sources and effects upon space systems.

This document is applicable for a variety of engineering and scientific domains. It is applicable to space system operations include ground-based, on-orbit, and deep space automated satellite operations. It can be applied by developers of software systems for space systems, designers of space systems, and launchers of space systems. Table 1 gives an overview of existing International Standards related to the space environment.

Table 1 — Terrestrial and Lunar Environment Standards

	LEO	PEO	MEO	GEO	>GEO
Testing/Analysis/Framework	ISO 15856, ISO 17851, ISO 21980, ISO 22295, (AUL ²)	ISO 15856, ISO 17851, ISO 21980, ISO 22295, (AUL ²)	ISO 15856, ISO 17851, ISO 22295, (AUL ²)	ISO 15856, ISO 17851, ISO 22295, (AUL ²)	ISO 15856, ISO 17851, (AUL ²)
Cosmic Rays	ISO 15390, ISO 17520, ISO 23689	ISO 15390, ISO 17520, ISO 23689	ISO 15390, ISO 17520, ISO 23689	ISO 15390, ISO 17520, ISO 23689	ISO 15390, ISO 17520, ISO 23689
Solar photons	ISO 21348, ISO 23689	ISO 21348, ISO 23689	ISO 21348, ISO 23689	ISO 21348, ISO 23689	ISO 21348, ISO 23689
Solar particles	ISO 16698, ISO 17520, ISO 18147, (solar wind), ISO 23689	ISO 16698, ISO 17520, ISO 18147, (solar wind), ISO 23689	ISO 16698, ISO 17520, ISO 18147, (solar wind), ISO 23689	ISO 12208, ISO 16698, ISO 17520, ISO 18147, (solar wind), ISO 23689	ISO 16698, ISO 17520, ISO 18147, (solar wind), ISO 23689
Solar fields	ISO 16698 (solar wind), ISO 23689	ISO 16698 (solar wind), ISO 23689	ISO 16698 (solar wind), ISO 23689	ISO 16698 (solar wind), ISO 23689	ISO 16698 (solar wind), ISO 23689
Main magnetic field	ISO 16695, ISO 16698, ISO 23689	ISO 16695, ISO 16698, ISO 23689	ISO 16695, ISO 16698, ISO 23689	ISO 16695, ISO 16698, ISO 23689	ISO 16695, ISO 16698, ISO 23689
Magnetosphere	ISO 16695, ISO 16698, ISO 19923, ISO 20584, ISO 23689, (PC index)	ISO 16695, ISO 16698, ISO 19923, ISO 20584, ISO 23689	ISO 16695, ISO 16698, ISO 22009, ISO 19923, ISO 20584, ISO 23689	ISO 12208, ISO 16695, ISO 16698, ISO 22009, ISO 19923, ISO 20584, ISO 23689	ISO 16695, ISO 16698, ISO 22009, ISO 19923, ISO 20584, ISO 23689
Radiation Belts	ISO 17761, ISO 20584, ISO 17520, ISO 21979, (IRENE ² , internal charge), ISO 23689	ISO 17761, ISO 20584, ISO 17520, ISO 21979, (IRENE ² , internal charge), ISO 23689	ISO 20584, ISO 17520, ISO 21979, (IRENE, internal charge), ISO 23689	ISO 20584, ISO 17520, ISO 21979, (IRENE, internal charge), ISO 23689	ISO 20584, ISO 17520, ISO 21979, (IRENE ² , internal charge), ISO 23689

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Plasmasphere	ISO 16457, ISO 20584, ISO 23689	ISO 16457, ISO 19923, ISO 20584, ISO 23689	ISO 16457, ISO 19923, ISO 20584, ISO 23689	ISO 16457, ISO 19923, ISO 20584, ISO 23689	ISO 16457, ISO 19923, ISO 20584, ISO 23689
Ionosphere	ISO 16457, ISO 16698, ISO 20584, ISO 23689	ISO 16457, ISO 16698, ISO 20584, ISO 23689	(topside)		
Neutral atmosphere	ISO 14222, ISO 11225, ISO 16698, (AO³, satellite drag), ISO 23689	ISO 14222, ISO 11225, ISO 16698, (AO³, satellite drag), ISO 23689	(He, H)	(He, H)	(He, H)
Micrometeoroids	ISO 14200	ISO 14200	ISO 14200	ISO 14200	ISO 14200
Debris	ISO 14200, (radiation debris)	ISO 14200, (radiation debris)	ISO 14200	ISO 14200	ISO 14200
Lunar					ISO 10788

¹AUL = Application Utility Level

²IRENE = International Radiation Environment Near Earth

³AO = atomic oxygen

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1062 Normative ~~References~~ references

There are no normative references in this document.

1073 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

aerodynamic drag

force derived from the kinetic energy of an orbiting object encountering an *atmosphere* (3.2) as a result of the work done against the object by the atmosphere

3.2

atmosphere

layer of gases surrounding a planet, moon, asteroid, or comet with species composition and temperature often described by altitude

3.3

deep space

region of space beyond the Earth's *atmosphere* (3.2) and magnetosphere and especially beyond the Moon's orbit

~~Geomagnetically~~ 3.4

geomagnetically induced currents (GICs) current

GIC

induced magnetic field variation caused by geomagnetic disturbances such as CMEs upon the Earth's magnetic field

3.5

geostationary Earth orbit

Earth orbit having zero inclination, zero eccentricity, and an orbital period equal to the Earth's sidereal rotation period

Note 1- to entry: This orbit allows a satellite to remain continuously over approximately the same point on the Earth's surface.

~~[Source]~~[SOURCE: ISO 24113:2023, 3.11, modified — The abbreviated term “GEO” has been removed; note 1 to entry has been added.]

3.6

geosynchronous Earth orbit

orbit with an orbital period equal to the Earth's sidereal rotation period

~~[Source: ISO 14200:2012(E), 3.3.]~~

3.7

heliosphere

region ~~of space~~ surrounding the Sun where the emanating solar wind dominates the interstellar medium

Note 1- to entry: It is the magnetosphere and outermost atmospheric layer of the Sun, taking the shape of a vast, bubble-like region of space, i.e., a plasma cavity formed by the Sun in the surrounding interstellar medium where the strength of the solar, interplanetary magnetic field is greater than that of the local galactic magnetic field.

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~~[Source]~~[SOURCE: ISO 15856:2010, 3.1.8, modified — The word "emanating" has been added; the original note 1 to entry has been replaced by a new one.] [ISO/DTR 23689](https://standards.iteh.ai/catalog/standards/iso/4e87fb3e-c6e5-4b84-81e0-6d2a2ae1a6a5/iso-dtr-23689)

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~~3.1 — interplanetary orbit~~

~~orbital trajectory involving two or more planets or other celestial bodies~~

3.8

low Earth orbit

Earth orbit with an apogee altitude that does not exceed 2 000 km

~~[Source: ISO 14200:2012(E), 3.9.]~~

3.9

MEO

medium Earth orbit

~~or mid-Earth's orbit [ISO 17851:2016, definition 3.2.3]~~

Earth orbit with apogee an altitude that is greater than 2 000 km but does not exceed 36 000 km