INTERNATIONAL STANDARD

ISO 14222

Second edition
2022-03

Space environment (natural and artificial) — Earth's atmosphere from ground level upward

Environnement spatial (naturel et artificiel) — Haute atmosphère terrestre

Reference number
ISO 14222:2022(E)

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Published in Switzerland

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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 documents 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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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 14222:2013), which has been technically revised.

The main changes are as follows:

— updated formulae, references to models, indices and links to websites;

— this document now applies to the Earth's atmosphere from ground level upward through the exosphere.

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 provides guidance for determining the properties of the Earth's atmosphere from ground level upward to the exosphere.

In the atmospheric regions up to approximately 100 km, a detailed knowledge of the average structure of the atmosphere as a function of geographic location, time in the year and solar activity is critical for the design of aircraft, balloon payloads, rocket launch activities and many other facets of modern society. The maximum departures from average conditions also need to be understood in order to provide a margin of safety in design and in operations. These features are included in this document.

A good knowledge of temperature, total density, concentrations of gas constituents, and pressure in the region above about 100 km is important for many space missions exploiting the low-earth orbit (LEO) regime below approximately 2 500 km altitude. In addition to the causes of variation of the atmosphere up to 100 km, geomagnetic processes may seriously affect the structure and dynamics of the thermosphere. Aerodynamic forces on the spacecraft, due to the orbital motion of a satellite through a rarefied gas which itself can have variable high velocity winds, are important for planning satellite lifetime, maintenance of orbits, collision avoidance manoeuvring and debris monitoring, sizing the necessary propulsion system, design of attitude control system, and estimating the peak accelerations and torques imposed on sensitive payloads. Surface corrosion effects due to the impact of large fluxes of atomic oxygen are assessed to predict the degradation of a wide range of sensitive coatings of spacecraft and instruments. The reactions of atomic oxygen around a spacecraft can also lead to intense "vehicle glow".

The structure of Earth's atmosphere and internationally accepted empirical models that specify the details of the atmosphere are included in this document. The annexes and references provide a detailed description the details of those models. The purpose is to create a standard method for specifying Earth's atmosphere properties (density, temperature, wind etc.) at all altitudes from ground level upward, including the low Earth orbit regime now widely-used for space systems and space operations.

The details of those models are included in Annex A.

Annex B provides a detailed description of the electromagnetic radiation and solar and geomagnetic indices.

Space environment (natural and artificial) — Earth's atmosphere from ground level upward

1 Scope

This document specifies the structure and properties of the Earth's atmosphere from ground level upward. It provides internationally accepted empirical models that specify the details of the atmosphere. It also refers to widely-accepted physical models providing insight into the physical and chemical processes driving the response of the atmosphere.

2 Normative references

There are no normative references in this document.

3 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
homosphere
region of the atmosphere that is well mixed

Note 1 to entry: The major species proportional concentrations are independent of height and location.

Note 2 to entry: This region extends from 0 km to ~100 km and includes the temperature-defined regions of the *troposphere* (3.2) (surface up to ~6 km to 18 km altitude), the *stratosphere* (3.3) (~6 km to 18 km up to 50 km altitude), the *mesosphere* (3.4) (~50 km up to about 90 km altitude), and the lowest part of the *thermosphere* (3.5) (~90 km to 125 km).

3.2
troposphere
lowest layer of the Earth's atmosphere

Note 1 to entry: It is also where nearly all weather conditions occur.

Note 2 to entry: The troposphere contains approximately 75 % of the atmosphere's mass and 99 % of the total mass of water vapour and aerosols. The average height of the tropopause is 18 km (11 mi; 59 000 ft) in the tropics, 17 km (11 mi; 56 000 ft) in the middle latitudes, and 6 km (3.7 mi; 20 000 ft) in the polar regions in winter. The global average height of the tropopause is 13 km.

Note 3 to entry: The lowest part of the troposphere, where friction with the Earth's surface influences air flow, is called the planetary boundary layer. The boundary layer is typically a few hundred metres to 4 km deep depending on the landform, latitude, season and time of day. The upper boundary of the troposphere is the tropopause, which is the border between the troposphere and *stratosphere* (3.3). The tropopause is an inversion layer, where the air temperature ceases to decrease with height and remains constant through its thickness.