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**Space environment - Geomagnetic reference models
(English Translation)**

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Reference

Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents" Drafting is required:

This document is modified to adopt ISO 16695:2014 "Geomagnetic field reference model for the space environment (natural and artificial)":

This document has the following structural adjustments compared to ISO 16695:2014:

--- Added two chapters: "Normative References" and "Terms and Definitions";

--- Appendix B corresponds to Appendix A of ISO 16695:2014:

This document has many technical differences compared to ISO 16695:2014: The outer margins of the clauses involved are marked with vertical A single line (|) is used to indicate these technical differences: A list of these technical differences and their reasons is given in Appendix A:

The following editorial changes were made to this document:

---Change the name of the standard to "Space Environment Geomagnetic Field Reference Model" to keep consistent with my country's technical standard system;

--- Re-annotate some of the figures in Figure 1, and re-annotate all the letters and symbols (ISO 16695:2014 in the text) that appear in the figure:

Some of the symbol definitions in the figure are indicated in the figure legend to keep consistent with my country's technical standard system (see Figure 1);

--- The statement "the unit vectors of the geomagnetic components X', Y' and Z' point to the ϕ , λ and $-r$ directions respectively" has been modified, where X' the component points to the $-\phi$ direction (see 5.2);

---The expression of formula (24) has been modified: Here is the coordinate transformation of the time derivative of the Z component of the magnetic field:

Add a ":" symbol (representing the time derivative) to the top of the field component [see formula (24)];

--- Added the example in 6:3 (see 6.3);

---Replace the external source field spherical harmonic coefficients g_{mn} and h_{mn} in formula (26), formula (32) to formula (42) with j_{mn} and k_{mn} respectively, so that Distinguish with the spherical harmonic coefficients of the internal source field [see formula (26),

formula (32) to formula (42)];

---According to user needs, the model URL was updated in Appendix B, and the external source field model was added;

--- Adjusted the references and added [6] to [9] according to the additional content:

Introduction

For centuries, the geomagnetic field reference model has been used to describe the geomagnetic vector field (direction and strength) as a function of position and time:

These models are widely used in the study of the upper atmosphere, ionosphere and magnetosphere, as well as in describing the near-Earth space environment; thus, they provide important references for spacecraft and ground-based systems:

It provides necessary reference for system navigation, route and attitude determination and subsystem control:

In these models, the geomagnetic field is represented by the spherical harmonic expansion of the scalar geomagnetic potential: This representation was first proposed by Gauss (1777-the spherical harmonic coefficients of the geomagnetic field expansion are usually called Gaussian coefficients:

The International Geomagnetism and Aerophysics Association (IAGA) proposed the International Geomagnetic Reference Model (IGRF), which uses Gaussian coefficients to describe the geomagnetic field:

This document reflects the established specifications of these models, including formulae and calculation procedures:

The Earth's magnetic field is observed from sources both inside and outside the Earth: All of these sources affect scientific or navigation instruments, but only some of them are at present, the main component of the geomagnetic field (accounting for about 95%) comes from the iron in the Earth's liquid outer core:

The magnetic field generated by water flow is called the core field/main magnetic field: The core field changes significantly every year, and the linear extrapolation of the Gaussian coefficient can be used to the International Geomagnetic Reference Model specifies the Gaussian coefficients for the start date (decade) and provides a set of future the secular variation (SV) coefficient for five years: Due to the unpredictable nonlinear changes in the core field, the reference model for predicting the geomagnetic field is only accurate within a specific period:

Valid, users will then need to update to the new version:

Other sources also affect the Earth's magnetic field: magnetic minerals in the crust and

upper mantle produce lithospheric magnetic anomalies, which can be very large locally:

Significant; the current generated by the conductive seawater flowing under the background magnetic field and cutting the magnetic field lines also has some weak contribution to the observed magnetic field; the upper atmosphere and the time-varying currents in near-Earth space generate external magnetic fields, which do not become zero over time: Their contribution can be obtained by using a linear time-varying the time-varying external magnetic field further induces induced currents in the earth and the ocean, generating secondary induced magnetic fields:

There is no general agreement on how to separate the various internal and external sources, so it is up to the developers of the geomagnetic reference model to specify which ones:

Both internal and external sources are included in their model, and restrictions are imposed on the radial range of applicability of the external source fields in the model:

Reference Model of Geomagnetic Field in Space Environment

1 Scope

This document specifies the requirements for modeling the geomagnetic field reference model, describing the geomagnetic field reference model at any location and time (including various endogenous fields and external fields, depending on the model maker):

This document is applicable to applications in various fields such as space environment, military defense, geotectonics and natural disasters:

2 Normative references

The contents of the following documents constitute the essential clauses of this document through normative references in this text:

For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version (including all amendments) applies to this document:

Note: GB/T 30170-2013 Geographic information - Coordinate-based spatial reference (ISO 19111:2007, IDT)

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in ISO 19111 and ISO 22009 and listed below apply:

geomagnetic potential A parameter that describes the energy/work properties of the Earth's magnetic field: