

IERS Conventions v2.0.0

2026 UAW, Munich, Germany

IERS Conventions Centre re-write contributors

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Chapter 2 General relativistic models for space-time coordinates and equations of motion	Ch 10	Michael Efroimsky Sergei Klioner	Sergei Kopeikin	James Hilton Sergei Klioner	Maria Davis
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Chapter 4 Terrestrial reference systems and frames	Ch 4	Frank Lemoine Dennis McCarthy	Zuheir Altamimi	Paul Rebischung Mathis Blossfeld	
Chapter 5 Transformation between the International Terrestrial Reference System and the Geocentric Celestial Reference System	Ch 5	José Ferrandiz Nick Stamatakos	Alberto Escapa	Dennis McCarthy	Maria Davis
Chapter 6 Geopotential	Ch 6	John Ries Srinivas Bettadpur	Jean Paul Boy		
Chapter 7 Displacement of reference points	Ch 7	VACANT	Jean Paul Boy	Dennis McCarthy Nick Stamatakos Dmitry Pavlov Kyriakos Balidakis	Maria Davis
Chapter 8 Tidal variations in the Earth's rotation	Ch 8	Sigrid Böhm	John Gipson	Christian Bizouard	Maria Davis
Chapter 9 Models for atmospheric propagation delays	Ch 9	Johannes Böhm		Manuel Hernandez Kyriakos Balidakis	Maria Davis
Chapter 10 General relativistic models for propagation	Ch 11	Michael Efroimsky	Sergei Kopeikin	Joseph O'Leary Sergei Klioner	Maria Davis

Chapter 1: General definitions and numerical standards proposed updates

Editors: Nick Stamatakos

• **Changes to content:**

- Several values of Table 1.1 – *IERS numerical standards* – will be updated based on IAG, IUGG, or IAU resolutions or generally accepted values
 - Complete list is to be presented in a poster at the UAW 2026: “Review of IERS Conventions Chapter 1 for Numerical Standards and IERS Conventional Values.”
 - Proposed changes will be shown on the poster to illicit comments before implementation.
- Table 1.2 -- *Parameters of the Geodetic Reference System GRS80* – to be moved to an Appendix or reference to avoid confusion with repeated definitions with different values in Table 1.1
 - For example, the value of the Geocentric Gravitational Constant GM_{\oplus} is different in Table 1.1 versus Table 1.2. For the reader who is not an expert, this may cause confusion as to which value is sanctioned by the IERS for usage in their program, model, or algorithm.

Chapter 1 proposed updates (continued)

- **Changes to content (continued):**

- Differences between Table 1.1 and Table 1.2 (proposed to be moved out of the main conventions section).
 - Note that, except for defining Constants in Table 1.1, the values correspond to best estimates which are valid at the time of this publication and may be re-evaluated as needed.
 - Table 1.2 contain *conventional values* developed for the Geodetic Reference System in 1980 and should be used by those users needing a conventional set of values for those parameters
- A paragraph is proposed to be added to identify the proposed replacement of the GRS80 system by a new system
 - Working group working towards an IAG/IUGG resolution in 2027 to replace GRS80 with a new Geodetic Reference System based on the IHRF chaired by Urs Marti.
- Mention will be made regarding the new International Height Reference System (IHRF). Work published by Laura Sánchez et al. 2021 will be referenced.
- Note: The GRS80 will be mentioned as the “standard” and the proposals on updates based on IHRF will be mentioned, but not adopted as part of the IERS Conventions for the 2026 update.

Chapter 2: General relativistic models for space-time coordinates and equations of motion proposed changes

Editor: Michael Efroimsky

- **Mathematical Notation and Metrics**

- The chapter introduces a detailed notation system and redefines BCRS and GCRS metrics with updated gravitational potentials.

- **Time Coordinate Transformations**

- Expanded transformation equations between TCB and TCG include high-order corrections and standardized time definitions per IAU 2006.

- **GNSS Timekeeping Advances**

- Detailed coverage of GNSS timekeeping addresses relativistic frequency shifts and system-specific time scales like GPST and GLONASSST.

- **Lunar Reference System and Dynamics**

- New lunar section defines Lunacentric coordinates and lunar time while expanding gravitational force models for precise orbit determination.

Chapter 2: General relativistic models for space-time coordinates and equations of motion proposed changes

Editor: Michael Efroimsky

- **Updated Time Standards**

- The revision replaces ambiguous TDB definitions with precise linear functions aligned to IAU 2006 resolutions.

- **Modern Ephemerides**

- Older ephemeris models like TE405 and HF2002 are deprecated, replaced by more accurate models such as DE440 and DE441.

- **Enhanced Relativistic Corrections**

- Simplified relativistic approximations are replaced with detailed equations covering multipolar gravity and tidal effects.

- **Formalized Mathematical Framework**

- Qualitative descriptions are substituted with formal mathematical expressions for clear scientific implementation.

Chapter 3: Celestial reference system and frame proposed updates

Editor: Patrick Charlot, Alet de Witt, Jean Souchay

- Changes to content
 - ICRF2 to be replaced by ICRF3
 - ICRF3 to be presented in a new “radio realization” sub-section following a short introductory paragraph on the ICRF
 - HCRF to be replaced by Gaia-CRF3 (currently sub-section 2.2.1)
 - Rework sub-section 2.2.2 (Availability of the frame)
- Content added
 - Current Chapter 3 (Conventional dynamical realization of the ICRF) to be updated and integrated as a new section. Add pertaining information currently in sub-section 2.2.2.
- Discussion points
 - Sections 2.1.1 (Equator) and 2.1.2 (Origin of right ascension) describe extensively how the orientation of the ICRS was defined 30 years ago. Should they be kept entirely or reduced? Interest is mostly historical.
 - ICRF1, ICRF2, and the HCRF are obsolete. Proposal is to mention them in the introductory paragraph(s) of the ICRF section without going into details. Is that OK?
 - Input needed on the current dynamical frames to recommend

Chapter 4: Terrestrial reference system and frame proposed updates

Editors: Frank Lemoine and Dennis McCarthy

- Changes to content
 - ITRF2014 to ITRF2020....

Chapter 5: Transformation between the ITRS and the GCRS proposed updates

Editors: José Ferrandiz and Nick Stamatakos

- **Changes to content and removals**
- **The length of Chapter 5 can be drastically reduced.** There is no longer a need to detail the significant changes in concepts and procedures introduced by the 2000 and 2006 IAU/IUGG Resolutions.
- However, the key points of these resolutions must be retained and concisely summarized.
- Definitions of axes and origins (e.g., CIP, CIO, and TIO); EOP; precession/nutation models; and CPO.
- The corresponding main formulae must be kept. Users are allowed by the former resolutions to choose a parameterization, but the majority of expressions in terms of obliquity and longitude can be removed since CPOs are mostly used in the convenient form dX , dY .
- Existing supplementary IERS corrections/models must be clearly stated, as well as how to acknowledge their use if optional. E.g., solid-Earth High-Frequency-Nutation (not those for PM in Chapter 8) or FCN models.
- **Content added — *see discussion points***
- **Some potential corrections could be added if agreed upon. They refer to:**
- **Updates by corrections to the precession IAU2006 and nutation IAU2000 models**
- **An account of FCN models that may or may not be offered. They are useful for predicting CPO from the EOP users' perspective, not only for science**
- **Updates to the solid-earth high frequency nutations and UT1 variations (not the ones in Chapter 8)**

Chapter 5 proposed updates: Discussion points

- Deciding on adopting the use of new CPO (2026?) referred to updated precession & nutation models, improved by adding these corrections to the precession and forced nutations :
 1. Updating the precession model to the IAU2006_J2 (Dec. 2025) to solve for the growing dX inaccuracy.
 2. Increasing the accuracy further by employing consistent nutations. Correcting planetary nutations with the main analytically derived non-rigid Oppolzer terms is essential. *(A complete replacement would be better, but would require more time to be applied effectively and the update is urgent)*
 3. Finally, completing the update of the conventional IERS models by choosing among these options:
 - a) including the already available corrections to IAU2000 corresponding to oceanic effects or BEP refit,
 - b) using semi-empirical corrections to the amplitudes of some nutation periods (~15) fitted to VLBI observations and statistically significant *(after tested with many different CPO solutions)*
 - c) A combination of the former two for increasing the accuracy using less empirical amplitudes
- Expected benefits:
 - A drastic reduction in the WRMS of the CPO, to ~120 μas (<4 mm) for the IVS combined solution.
 - CPO time series could be corrected immediately without the need for prior reanalysis.
 - Improved CPO predictions, FCN models, and reference frames are likely based on results from tests conducted so far within the IAU/IAG JWG CIERT.

Chapter 6: Geopotential proposed updates

Editors: John Ries and Srinivas Bettadpur

- Changes to content
 - Chapter 6 – Front matter – Who is the target for this chapter?
 - Edit for readability
 - Section 6.1 – Update Mean Gravity Model
 - Update beyond EGM2008
 - Edit – Permanent tide and tidal aliasing in GRACE appear to be mixed-up??
 - Edit for readability
 - Section 6.2.1 (Body tides) – Edit for readability
 - Separate the calculation recipe from explanation of theoretical bases
 - Edit for readability (at 8 pages, this section is too long)
 - Section 6.2.2 (Permanent tide) – Edit for readability
 - Section 6.3 (Ocena tide) – Update to new tide models, they are notably better in GRACE(-FO) use
 - Section 6.4 to 6.6 – No edits anticipated (??)
- Content added – None needed
 - Though a literature review may not be amiss
- Content removed - None
- Discussion points
 - No feedback from IAG Commission.2 (Steering Cmte, Sub-Commissions, and all (J)S/WG)
 - Emphasizes the need to identify who the chapter is written for.
 - What is the connection of Ch.6 to height systems or the GRF?
 - Inconsistencies to be resolved – none evident

Chapter 7: Displacement of reference points proposed updates

Editor: VACANT

- Changes to content?

Chapter 8: Tidal Variations in the Earth's Rotation proposed updates

Editor: Sigrid Böhm

- Changes to content – exchange of models, adaption of text
 - Diurnal and semi-diurnal variations due to ocean tides → Desai & Sibois (2016)
 - Possibly also: zonal tidal variations → Ray & Erofeeva (2014)
- Content added
 - Alternative models could be added to supplementary material as tables which are readable by the provided software
- Discussion points
 - Change from Woolard arguments to Doodson arguments?
 - Should alternative models be provided?

Chapter 9: Models for atmospheric propagation delays proposed updates

Editor: Johannes Böhm

- For optical wavelengths:
 - No updates but new
 - Optional solutions: Horizontal gradient models to increase the consistency between microwave and optical techniques, as well as mapping functions based on data from numerical weather models
- For microwaves:
 - No updates, but consolidation (VMF3/GPT3 instead of variety of models)
- Ionosphere:
 - No updates in recommendation
 - Outlook: synergies in second order ionospheric effect (Faraday rotation) between radioastronomy observations (LOFAR) and GNSS-based ionospheric models

Chapter 10: General relativistic models for propagation proposed changes

Editor: Michael Efroimsky

- Old:
 - 1991 consensus VLBI model; picosecond accuracy; classical geometric + gravitational + atmospheric delay decomposition.
- New:
 - Modern relativistic propagation (BCRS/GCRS, IAU 2000), sub-ps precision; full GR derivations.
- Gravitational delay:
 - old light closest-approach method replaced by rigorous retarded-time formulation.
- Geometric delay:
 - expanded baseline- and antenna-based delays with velocity/acceleration terms.
- Atmospheric delay:
 - replaces phenomenological correction with fully relativistic Fresnel–Fizeau derivation.

Chapter 10: General relativistic models for propagation proposed changes

Editor: Michael Efroimsky

- Key Updates

- New additions: N-station VLBI support; secular aberration; modernized SLR/LLR/spacecraft ranging.
- Deprecated: closest-approach gravitational time; partial atmospheric model; missing velocity-dependent terms.
- Clarified interpretation of TT- vs TCG-compatible coordinates in VLBI and SLR.
- Retarded-time gravitational corrections now standard for high-precision IERS applications.

Thank you to the contributors!

Questions/Discussion