

A REFINED DEFINITION OF THE INTERNATIONAL TERRESTRIAL REFERENCE SYSTEM

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ABSTRACT. Recent discussions have shown the need to upgrade and refine the definition of the International Terrestrial Reference System (ITRS). This presentation reviews the various issues, in particular related to the scale and origin. It also looks at the impact on IERS activities (ITRF and conventions), on the need to modify the related IUGG resolution, as well as the ongoing ISO standard related to ITRS.

1. BACKGROUND

Terrestrial Reference Systems (TRS) refer to an important domain of Geodesy, involving both theoretical and applied aspects, as well as deep connections with Astronomy, Earth Sciences and Geo-information. The concept of TRS designates any mathematical reference frame co-moving with the Earth in space, which immediately implies several visions for TRS:

- An astronomical vision, using TRS to study translational and rotational motion of the Earth in inertial space
- An Earth Science vision, using TRS to build physical models of the Earth system, and its various components (solid earth, oceans, atmosphere, hydrosphere)
- A metrological vision, using TRS together with suitable coordinate systems (geographical coordinates, map projections) to define geographical position of objects in the Earth's vicinity

The need to define and adopt a unique preferred TRS is widely recognized both for scientific, technical and societal reasons.

During the last thirty years, astronomers and geodesists developed a series of joint activities in this field, starting with the MERIT and COTES projects at the beginning of 80's, followed by the creation of the International Earth Rotation and Reference Systems Service (IERS) in 1988, jointly by the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG). IERS is in charge to propose a detailed definition of such a unique and preferred system, designated under the name of International Terrestrial Reference System (ITRS). IERS is also in charge to determine a series of primary realizations of ITRS, designated as International Terrestrial Reference Frames (ITRF), in addition to a comprehensive description of relevant conventions, known as IERS Conventions (Petit, Luzum, 2010)

Meantime IAU adopted the IAU 2000 system, and established an action to modernize the nomenclature in Fundamental Astronomy, to which IAG took part, in order to develop consistent definitions between astronomical and geodetic communities. This led IAG to propose to get a more formal definition of ITRS, officially adopted by the IUGG through its Resolution 2 of the Perugia General Assembly (2007). Considering the need to promote these results in a consistent way within the whole geodetic community, the International Association of Geodesy (IAG) like IAU did, expressed the need for a unified and accepted terminology related to basic TRS-related concepts and consequently established an inter-commission working group (ICWG 1-3) on "Concepts and terminology related to Geodetic Reference Systems".

Presently, some issues are raised upon the necessity to refine the present definition of ITRS.

2. WHY TO REFINE THE DEFINITION OF ITRS ?

Following the three faces mentioned before for TRS, we can mention several of these issues:

On an astronomical view, the main current problem is to establish a rigorous definition of ITRS within the framework of the background relativistic model presently adopted by IAU (Soffel et al 2003). Such a definition must be in particular consistent with currently used time scales and the transformation formula to celestial system.

On a geophysical view, it is important to have a very precise definition which can be embedded into geophysical models. One can mention some of the relevant topics:

- motion of the geocenter
- sea level variations
- global rotation of tectonic plates (NNR, hot spots...)

On a metrological view, the adopted definition for ITRS must be tridimensional and consistent with the Terrestrial Time (TT)

3. DISCUSSION ISSUES

• **dimension of ITRS**

The current situation is inconsistent. The IUGG resolution explicitly consider ITRS as a specific Global Terrestrial Reference System (GTRS) which is a local coordinate system in the relativistic framework, and therefore 4-dimensional. The IAG WG recommends ITRS to be tridimensional. This is the present proposed choice.

• **scale of ITRS**

As specific GTRS, the ITRS scale is consistent with TCG. Most people who already gave an opinion about this point are in favor of a scale consistent with TT. The new definition should then follow this choice, if this preferred opinion is confirmed.

• **origin of ITRS**

Two main options are considered for the origin :

- either the center of mass of the whole Earth system, including atmosphere, ocean and continental water, which is the current option
- or to choose an origin linked to the solid Earth, such as its center of mass, or a center of figure

The pro and contra of these options are presently under investigation.

Additional discussion could also be raised concerning the ITRS orientation, including its time evolution.

4. CONCLUDING REMARKS

Further contributions are expected to fix the choice for each item. These choices must be then translated into a relativistic definition of ITRS, following the present IAU formalism. Finally an new IUGG resolution will be required to publicize this.

5. REFERENCES

- Petit G, Luzum B, 2010, IERS Conventions (2010), IERS Technical Note 36
Soffel M et al, 2003, The IAU 2000 resolutions for Astrometry, Celestial Mechanics and Metrology in the relativistic framework