Requirements for Earth Rotation Parameters

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ABSTRACT Observations of Earth orientation parameters (polar motion and Universal Time) have reached a level of accuracy which challenges the definition of the reference systems which these observations seek to relate. Observational accuracies of better than $\pm 0''.002$ in polar motion and $\pm 0^s.0002$ in Universal Time are now routinely available. Urgent requirements therefore exist now for the IAU to take a fresh look at the concepts and definitions of the reference systems as well as reference frames. Of particular concern are the definitons of the equinox, the terrestrial reference pole, the zero of longitude and sidereal time.

INTRODUCTION

Polar motion and Universal Time together are referred to as Earth Rotation Parameters. The polar coordinates, x and y, provide the direction of the celestial reference pole in an Earth-fixed coordinate system. Universal Time (UT1) provides a measure of the rotation angle of the Earth with respect to a reference frame defined in a space-fixed system.

These quantities make it possible to complete the transformation between space-fixed and Earth-fixed reference frames. The theories of precession and rotation are also required, but the observed Earth rotation parameters are essential for the specification of the complete rotation matrix (see, for example, papers in Gaposchkin and Kolaczek, 1981). This information is required by users in the fields of geodesy, geophysics, and navigation as well as in astronomy.

Joint IAU-IUGG working groups known as Project MERIT (for Monitor Earth Rotation and Intercompare Techniques) and COTES for Conventional Terrestrial Reference System) have been established recently for two purposes. MERIT is investigating the precision, accuracy, consistency, and overall suitability of modern observational techniques for monitoring Earth rotation. COTES was formed to make recommendations regarding a conventional terrestrial reference system for use in monitoring Earth rotation, particularly since the traditional system defined by the astronomical coordinates of a few optical telescopes was passing out of existence because the instruments were no longer being used.

In July, 1985 these groups held a joint meeting to report on progress and make recommendations for the future. The report of this meeting, summarized elsewhere in this volume by Wilkins, points out that the routine observational accuracy using modern techniques is now $\pm 0''.002$ in polar motion and $\pm 0^s.0002$ in UT1-UTC. The definitions of reference systems must be accurate to at least this

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level in order to keep pace with current observational abilities. Future improvements in observational techniques will require even more accurate definitions of the reference systems.

CURRENT REFERENCE SYSTEMS

A reference system includes a reference frame of observable positions and motions as well as a set of theories and/or constants suitable for transferring the frame to other orgins or epochs. The reference systems currently used in the determination of Earth rotation are summarized in the Project MERIT Standards (Melbourne, et al., 1983). Briefly, the conventional celestial frame is the FK5 frame as defined in practice by the various observational techniques. The conventional terrestrial frame is defined in principle by the Conventional International Orgin and the Bureau International de l'Heure (BIH) zero of longitude. In practice , both the conventional terrestrial and celestial frames are realized by a set of positions and motions of observing stations and sources which are observed. Frequently, a number of ad hoc "systematic corrections" are also included in the reference systems to account for changes in the observational systems.

FUTURE REQUIREMENTS

The specification of reference systems must exceed observational accuracy in its constants and theories, and since the systems are often used by those who are not experts in astronomical and geophysical theories, efforts must be made to simplify the concepts and to provide clearly defined transformation procedures. Reference frames should be highly accurate, self-consistent, non-rotating and accessible to users. The current recommendations of Projects MERIT and COTES include technical concepts calling for the celestial frame to be defined by positions of distant radio sources and the terrestrial frame to be defined by the positions and motions of observatories fixed to the Earth's crust. An international service will maintain the procedures and data to transform between realizations of these frames, and these procedures will be consistent with current best estimates of physical constants and theories.

These recommendations address some of the areas of concern. However, some basic concepts need to be clarified or changed to remain in step with current observational ability. These include (1) the definiton of an equinox in an era of numerically integrated planetary orbits, (2) the definition of a terrestrial reference pole and zero of longitude and (3) the definition of sidereal time free of the concept of a rotating fiducial point.

It is important to realize that the areas outlined above are of immediate concern and that we cannot wait for deliberations at some unspecified time in the future. It is the responsibility of the IAU to act on these issues as soon as possible in order to maintain concepts and realizations of reference systems relevant in a world of improving observational abilities.

References

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