Newsletter 5 of the subgroup T5 of the IAU WG ICRS : Preliminary conclusions, proposals and recommendations

(N. Capitaine, 17 March 2000)

The proposal for a new definition of the CEP and for new parameters for Earth orientation in the ICRS will be under discussion at the IAU Colloquium 180 in Washington at the end of March. It is to be hoped that a proposal on these issues can be endorsed by the subgroup T5 (which is in charge of these issues) and can be presented to this Colloquium 180 for a recommendation.

The present Newsletter of the subgroup T5 is devoted to the preliminay conclusions of the discussions concerning a modern definition of the CEP and new parameters for representing the orientation of the Earth in the ICRS and to proposals and preliminary recommendations on these issues for the IAU Colloquium 180.

It includes the following sections :

1. Conclusions of the discussion concerning a modern definition of the CEP and proposal
2. Conclusions of the discussion concerning new parameters for Earth orientation and proposal
3. Proposed recommendations for the IAU Colloquium 180

The individual answers and comments to the questions of the Newsletteres 3 and 4 are given in an Annex to this Newsletter.

1 Conclusions of the discussion concerning a modern definition of the CEP and proposal

A summary of the main points of the comparison between two possible options for a modern definition of the CEP and preliminary proposal is given below.

Option (1): Mathews's proposal (Journees 1998) is to define the CEP by keeping the symmetry in the frequency band between terrestrial motion and celestial motion in extending the definition outside the current frequency interval; the proposed procedure for its realization is to estimate simultaneously, in processing the observations, the current celestial pole offsets and

current polar motion as well as the high frequency signal in a symmetric way in the frequency domain in the CRS and TRS.

Option (2): the CEP is defined by separating the motion into the retrograde diurnal component of the motion wrt the TRS, which is considered as being long periodic motion in the CRS (periods larger than 2 days mainly due to the effect of the external torque on the Earth) and the motion wrt the TRS consisting of the whole complementary part of the motion; the proposed procedure for the realization of the CEP is to use the best model for precession nutation (periods longer than 2 days) in the estimation of the EOP (estimating the celestial pole offsets if possible) and then to extract the high frequency signal (or rather corrections to an empirical model for this signal) from the pole coordinates only.

Both choices (1)and (2) correspond to a clear concept not dependent on further improvements in the model. Both of them extend the current definition in order that the current definition is an approximation of the new one and has minimal impact on users. Both can be realizable by a model as accurately as possible..

It must be noted that the essential content of Mathews's proposal at the Journees 1998 was the method for estimation for the higher frequency components, whether in the CRS or TRS. The suggestion for distribution of the different frequency components between the CRS and TRS was incidental, and was purely a matter of aesthetics. Then, it does not really matter what part of the higher frequency spectrum is estimated in one frame and what part in the other, or whether all of it is estimated in just one of the two frames.

The advantage of (1) is its clear mathematical basis.

The advantage of (2) is its clear relation with a deterministic approach.

The preliminary proposal presented in the Newsletter 3, which appears to be the "preferred" option, corresponds to the choice (2).

Concerning its realization, precession and nutation are specified by the best available model including the components with periods larger than 2 days and the high frequency signal in the TRS is specified by a model including the tidal variations in polar motion and the terms corresponding to the sub-diurnal nutations. The corrections to these models are estimated in two steps : the first step corresponds to the current procedure for estimating the EOP (including when it is possible the celestial pole offsets); the second step is the estimation of the high frequency motions from the currently estimated coordinates of the pole.

The reasons for this choice, which considers the whole high frequency

motion in the TRS are that: - the prograde diurnal nutations (ampl in Deltapsi x sin eps and Delateps : 15 microarseconds) appear as long periodic polar motion which cannot be separated from the polar motion itself of much larger amplitude, - the semi-diurnal prograde nutations (ampl in Deltapsi x sin eps and Delateps : 15 microarseconds) appear as prograde diurnal variations in polar motion and cannot be separated from the much larger components (150 microarseconds) of the tidal variations of polar motion.

The proposed realization is such that it can be applied to all the techniques, whereas it is not the case of (1).

2 Conclusions of the discussion concerning new parameters for Earth orientation and proposal

A comparison of the parameters considered above shows that Euler's angles (described in (iii)) or equivalently the celestial coordinates of the z-axis of the TRS (described in (viii)), which reduce to three the number of EOP, do not use any intermediate pole and consequently include both high frequency and low frequency components of the motion of the z-axis of the TRS wrt the CRS.

The other parameters separate the celestial components from the terrestrial components according to a "frequency criteria" using an intermediate pole. Such a procedure facilitates the estimation of the parameters from observations, unless the model for low frequency motion in space is perfect.

The difference between the use of a geometrical origin (as Σ or K for examples) and a kinematical origin (σ) is that, in the first case, the instantaneous rotation of the considered origin is included in the derived value for the Earth's angle rotation, whereas it is clearly separated when using directly σ as the origin on the moving equator.

3 Proposed recommendations for the IAU Colloquium 180

Recommendation concerning the Celestial Ephemeris Pole

IAU Colloquium 180 "Towards Models and Constants for Sub-Microsecond Astrometry"

Noting the need for accurate definition of reference systems brought about by unprecedented observational precision, and

Recognizing that it is necessary to abandon the conceptual definition of the Celestial Ephemeris Pole as the pole that has no nearly diurnal motion,

Recommends

1. that the Celestial Ephemeris Pole be the pole of the equator the motion of which, with respect to the International Celestial Reference System, is produced by external gravitational forces acting on the Earth,

1. that at J2000.0 the direction of the Celestial Ephemeris Pole be coincident with the direction of the International Celestial Reference Pole at J2000,

2. that the direction of the Celestial Ephemeris Pole in the International Celestial Reference System at any epoch be defined in part by a nutation model containing only predictable components of nutation with periods greater than two days,

3. that the motion of the Celestial Ephemeris Pole in the International Celestial Reference System be specified by
a. precession/nutation formulation designated as the MHB2000 model plus
b. additional corrections provided by the International Earth Rotation Service through appropriate astro-geodetic observations plus
c. the geodesic nutation, and

4. that the motion of the Celestial Ephemeris Pole in the International Terrestrial Reference System be provided by the International Earth Rotation Service through appropriate astro-geodetic observations.

Recommendation concerning the Celestial Ephemeris Origin

IAU Colloquium 180 "Towards Models and Constants for Sub-Microsecond

Astrometry"

Recognizing the need for reference system definitions suitable for modern observational accuracy,

Recommends

1. that the Celestial Ephemeris Origin of the International Celestial Reference System be the non-rotating origin, and

2. that the time scale UT1 be defined as being proportional to the Earth Rotation Angle defined by the angle measured along the equator between the direction of the International Terrestrial Reference Origin and the Celestial Ephemeris Origin.

Recommendationconcerning the transformation between Terrestrial and Celestial Reference Systems

IAU Colloquium 180 "Towards Models and Constants for Sub-Microsecond Astrometry"

Noting the need for accurate definition of reference systems brought about by unprecedented observational precision,

Recommends

that the transformation between the Terrestrial and Celestial Reference Systems be specified by the position of the Celestial Ephemeris Pole in the Celestial Reference System, the position of the Celestial Ephemeris Pole in the Terrestrial reference System, and the Earth Rotation Angle defined by the angle measured along the equator between the direction of the Terrestrial Reference Origin and the Celestial Ephemeris Origin.