ACTIVITIES OF THE ICRS-PC OF THE IERS

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ABSTRACT. From January 2001, the Paris Observatory and the US Naval Observatory (USNO) propose to act jointly as the International celestial reference System Product Centre (ICRS-PC) of the IERS. We present hereafter the various activities of this product centre, insisting particularly on the present studies.

1. INTRODUCTION

The IERS shares the responsibility of monitoring the International Celestial Reference Frame (ICRF) as well as maintaining and improving the links with other celestial reference frames. Starting in 2001, these activities are run jointly by the ICRS Product Centre and the International VLBI Servive for geodesy and astrometry (IVS). Information about the ICRS-PC can be found on the ICRS Product Centre web site (http://hpiers.obspm.fr/icrs-pc) or via anonymous ftp (hpiers.obspm.fr/icrs-ps). We summarize in the following the various activities of the Product Centre.

2. MAINTENANCE OF THE ICRF AND OF ITS TIME STABILITY

Since the adoption of the ICRF as a catalogue giving the coordinates of 212 sources qualified as "'defining"' objects of the frame (Ma et al.,1997,1998), the ICRS-PC has performed several analysis in order to investigate the way by which the ICRF might be improved in the future. Recently an alternative selection of sources, based on an analysis of time series of radio sources coordinates over the period 1989-2002 has been proposed (Feissel-Vernier,2002). The improvement of the quality of the ICRS which might result from such a selection has been shown (Arias and Bouquillon, 2004). In particular the last authors selected two independent VLBI catalogues elaborated from two independent VLBI analysis. After comparison of the catalogues above to a rigid frame, that is, to ICRF-Ext.1, they concluded that the orientation of the axes of the ICRS is better realized by using the set of stables sources selected by Feissel-vernier(2003). This significant result suggests that statistical tests be considered when selecting a set of sources to

materialize the ICRS in the future.

3. INVESTIGATIONS OF FUTURE REALIZATIONS OF THE ICRF

The personnel from the ICRS Centre has been deeply involved in the recent VLVI programs and their evolution with an increasing number of quasars observed in the southern celestial hemisphere and a lot of new additional observations of the ICRF quasars in the northern hemisphere. This densification has enabled the construction of a second extension of the ICRF, called ICRF-Ext.2 (Fey et al.,2004) which was accompanied by an improvement in the accuracy of the coordinates of the "candidate" and "'other"' sources, according to the usual terminology used for the ICRS (IERS Technical Note,2003). Notice that the ICRF-Ext.2 solution differs from the precedent versions (ICRF and ICRF-Ext.1) in the use of the NMF mapping function (Niell,1996) for the tropospheric modelling, which constitutes one of the leading limitations in the reductions of VLBI observations.

4. INVOLVEMENT OF THE ICRS-PC IN VARIOUS VLBI ASTROMETRIC PROGRAMS

The USNO personnel of the ICRS-PC, in collaboration with other teams from the NASA, the NRAO (National Radio Astronomy Observatory), the GSFC (Goddard Space Flight Center) is presently working to the extension of the ICRF to 24GHz and 43 Ghz in addition to the two "classical" frequencies of 2.3 GHz and 8.4 Ghz, through the important VLBA (very Long Baseline Array) program. A Radio Reference Frame Image Database (RRFID) can be accessed through the site "www.usno.navy.mil/RRFID", containing more than 3000 VLBA images at 2.3 GHz and 8.4 Ghz and more than 500 images at 24 and 43 Ghz. A joint program between USN staff and Whitier College consists in measuring apparent jet velocities from the motion of extragalactic sources components using RRFID data at 8.4 Ghz (Piner et al.,2003), showing apparent component speeds at rather low values (of the order of $1c$, where c is the speed of light), but with some values extending as high as $30c$ (IERS Technical Note,2003).

5. MAINTENANCE OF THE LINK TO THE HIPPARCOS AND OTHER OPTICAL CATALOGS

One of the most fundamental tasks of the ICRS-PC is to maintain the link between the ICRF, whose characteristics are determined at radio-wavelengths, and the primary optical Hipparcos catalog. This link is possible through the recent UCAC (USNO CCD Astrograph Catalog) observation program which is now achieved. The catalog contains the coordinates and magnitudes of roughly 50 million of stars with proper motions, covering roughly 90 % of the sky. Proper motions were derived from various other catalogs, as AC2000, Tycho, and remeasurements from older programs as AGK2, NPM and SPM plates. the extragalactic link was possible by identifying about 70 QSO's source fields within the UCAC fields, with the KPNO (0.9 m) and NOFS (1.3 m) telescopes.

The ICRS-PC also worked to the cross-identification between the quasars of the ICRF and those given by an up-dated version of the most extended quasars catalog (Véron-Cetty and Véron ,2003) at optical wavelengths. Notice that below a threshold of 0.4" for the search of a couterpart, only 132 sources among the 212 defining sources of the ICRF, i.e. roughly 62.2 % where found in the Véron-Cetty and Véron catalog. We can conclude that it should be interesting to complete the optical observations of ICRF source fields (IERS Annual Report,2003).

6. LLR AND PULSAR TIMING OBSERVATIONS FOR THE LINK TO THE DYNAMICAL SYSTEM

One of the important taks of the ICRS-PC concerns the link of the ICRF to the dynamical frame which is materialized by the position of the ecliptic. Indeed, all the motions of celestial bodies belonging to the solar system are referred to the ecliptic, and the accuracy in the determination of the orbital elements of these bodies is directly dependent on the accuracy of the position of the ecliptic. This can be done in two completely different ways, through pulsar timing analysis (Fairhead, 1988) and through Lunar Laser Ranging (Chapront et al.,2002; Chapront and Francou,2003). The first kind of analysis lead to the interesting result that the angular distance between selected pulsars is nearly not sensitive to the choice of the ephemerides used for the orbital motion of the Earth (as JPL ephemerides DE405 and DE200). Even when changing the ephemerides, these inter-pulsar angular distances are constant at the level of $1mas$" whereas on the contrary the equatorial coordinates are changed at the level of $10mas$. This suggests the elaboration of a very accurate and rigid celestial reference frame based on the positions of pulsars, from which in return a more accurate positioning of the ecliptic might be deduced. In parallel, Lunar Laser Ranging analysis enable to determine, through a complex combination of ephemerides (rotation of the Earth, librations of the Moon, orbital motion of the Moon etc...) and with high accuracy, the relative motions of the equator and the ecliptic at a given date (for instance J2000.0). Results concerning the position of the equinox as well as the obliquity are given at the level of a sub-milliarsecond accuracy (IERS Technical Note, 2003).

7. REFERENCES

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