

COMPARISON BETWEEN THE ILS-MD AND HIPPARCOS CATALOGUES

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ABSTRACT

Studies on the long-period variations of the Earth's rotation pole with the Earth's crust are mainly based on the results obtained by the International Latitude Service (ILS) in the time interval 1900-1980. These results are referred to the Melchior-Dejaiffe (MD) and partly, after 1967, to the Boss (GC) reference catalogues. In view of a new re-reduction of the whole set of ILS latitude observations in the Hipparcos reference frame, we have analyzed the differences in position and proper motion HIP – MD and HIP – GC, and compared them with the internal corrections derived from the observations themselves.

Key words: polar motion; optical astrometry; Hipparcos.

1. INTRODUCTION

The complex motion of the deformable Earth's rotational axis with respect to the crust of the Earth (polar motion) exhibits secular, periodic and irregular variations because of several geophysical and meteorological causes, some at present still unexplained.

The principal source for research on this subject, especially concerning secular and long-period terms, is the series of polar coordinates provided by the International Latitude Service (ILS), a chain of three to six observatories around the world, all on the same latitude with identical instruments and observing programs (Figure 1). The ILS, established in 1899 by the International Association of Geodesy, initially as a short campaign to monitor polar motion, operated until 1980 providing more than 770 000 individual values of observed astronomical latitude.

Several reductions of the ILS data have been published in the past, but at present the most homogeneous series – pole coordinates and the so-called Kimura-term on monthly basis – is the one published by the International Polar Motion Service (IPMS) with reference to the Conventional International Origin, based on the IAU 1964 System of Astronomical Constants (Yumi & Yokoyama 1980).

The importance and scientific goals of a new reduction of this series, especially in the framework of a general new reduction of the existing series of Earth Orientation Parameters from optical astrometry in the Hipparcos reference frame, are pointed out in several works (Kovalevsky 1982, Capitaine 1991, Vondrak 1991a, Vondrak 1991b, Poma & Uras 1996).

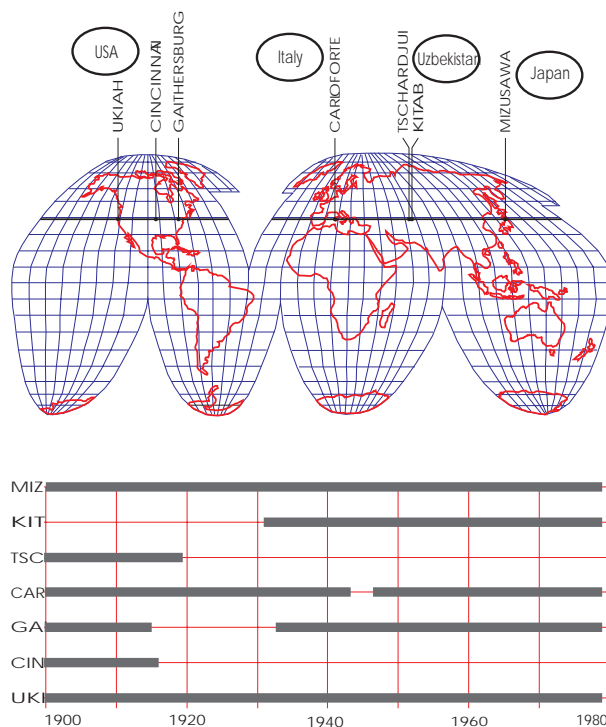


Figure 1. The International Latitude Service (ILS) chain on the parallel $39^{\circ} 08'$: geographic distribution and period of activity.

It should be noted that, conceptually, the ILS coordinates of the pole are independent of errors in the apparent declination or proper motion if all groups are completely observed in all the ILS observatories. This is not always so, certainly during some years of poor observations. Consequently the position corrections can slightly change the final polar motion values and surely affect the Kimura-term making difficult the possible geophysical interpretation of it.

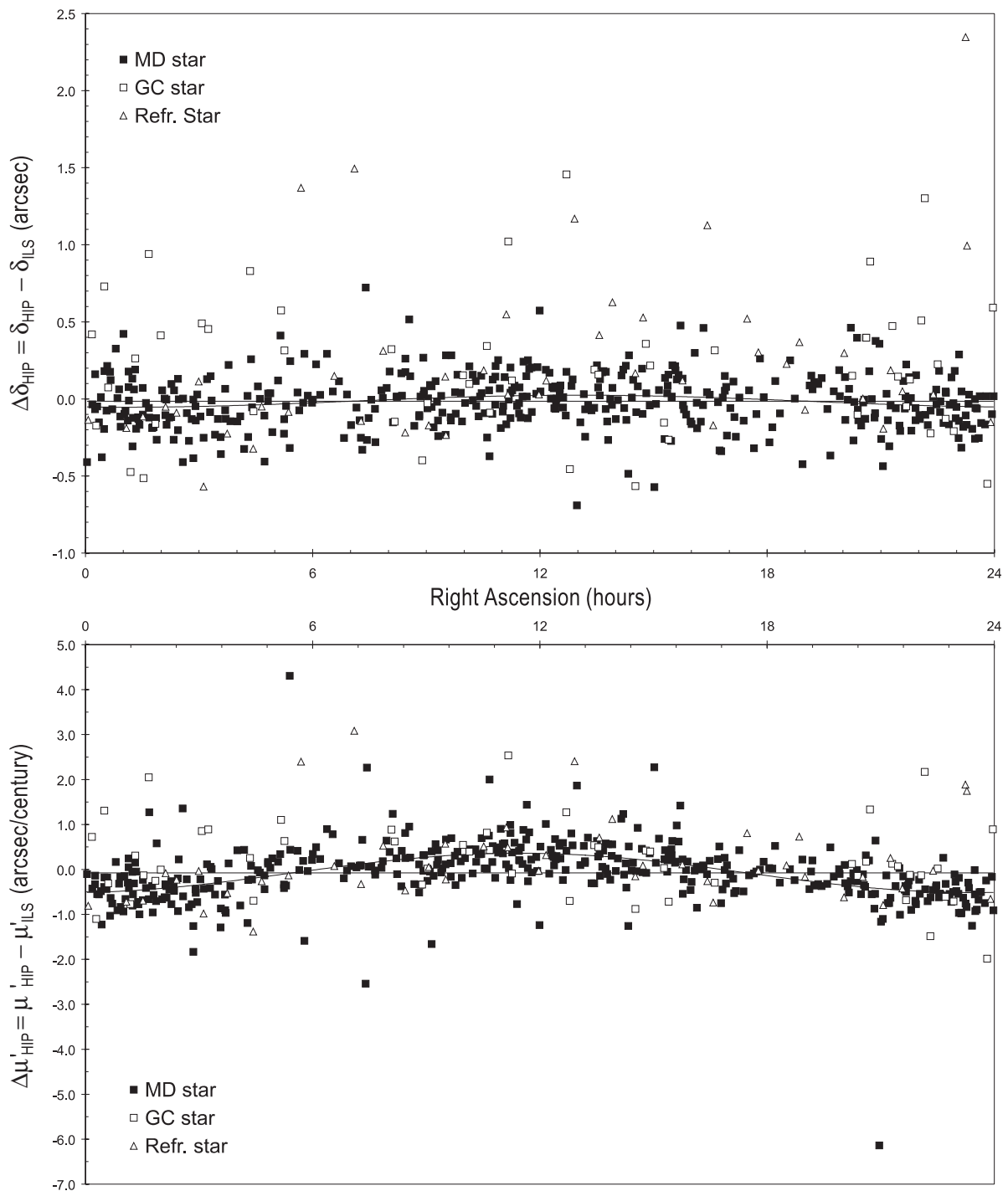


Figure 2. Declination and proper motion in declination differences for the ILS stars between the Hipparcos and the MD-GC catalogues, plotted as a function of the right ascension. Solid lines show the mean values and the sinusoidal components best fitting the data.

On the other hand, considering the great number of observations carried out for several stars of the ILS list, the possibility of improving some of the Hipparcos proper motions in declination from the oldest latitude observations, cannot be neglected (Vondrak et al. 1992).

2. THE ILS CATALOGUE

Each individual latitude φ in the ILS database is obtained by combining the calculated average declination of a star pair with their observed zenith distances by means of the well known Horrebow-Talcott's for-

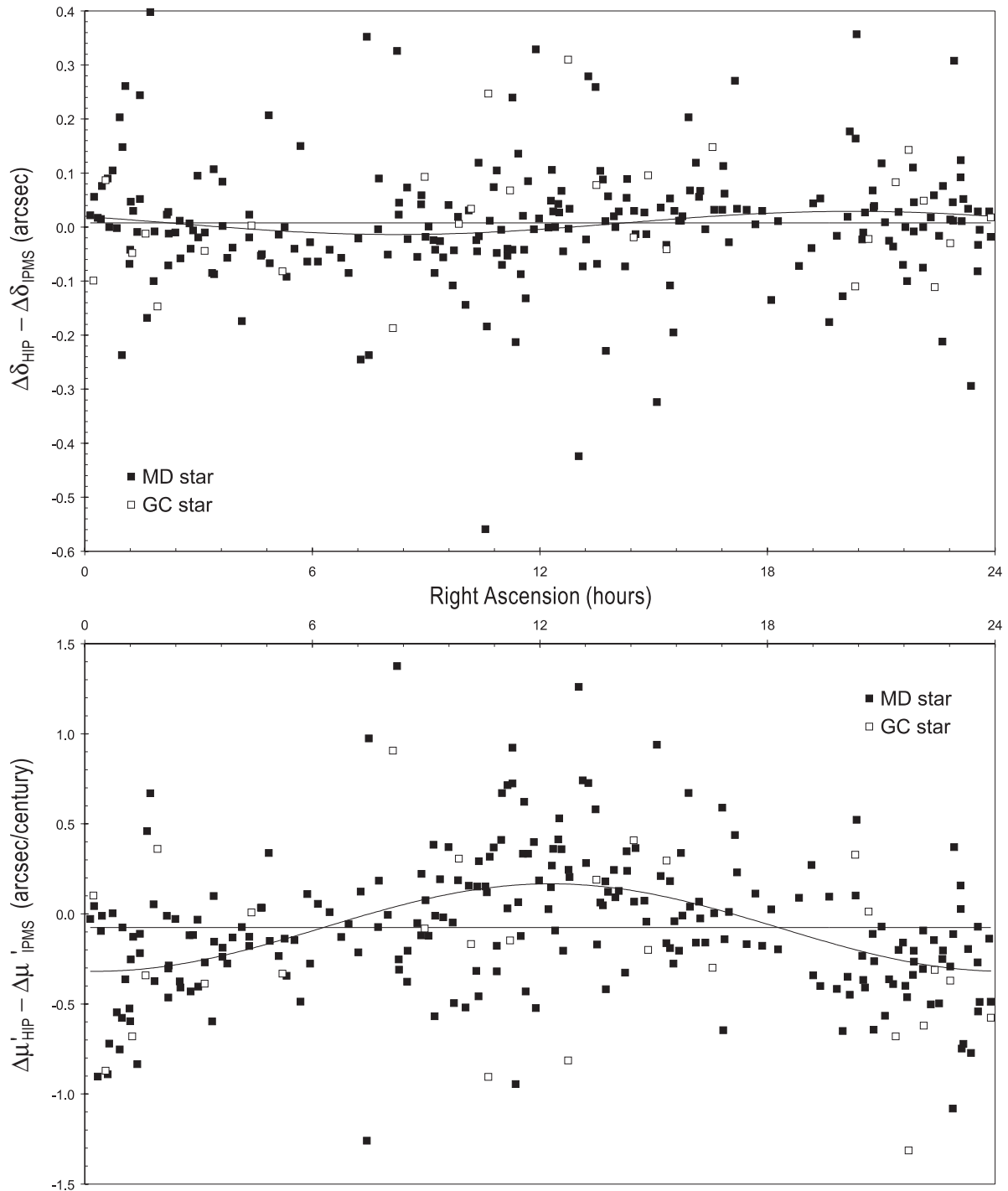


Figure 3. Declination and proper motion in declination correction differences between the ones derived from Hipparcos catalogue and the correspondent ones previously adopted by IPMS.

mula:

$$\varphi = \frac{1}{2}(\delta_N + \delta_S) + \frac{1}{2}(Z_N - Z_S)$$

where the quantity $Z_N - Z_S$, that varies with time due to precession, must be maintained smaller than the telescope field. Moreover, $\sum (Z_N - Z_S)$ must be kept as near to zero as possible in each group of stars (about two hours of right ascension) for minimizing some instrumental errors. For these reasons, the ob-

serving program has often been updated by replacing a part of star pairs. Seven different star lists – hereafter referred to as program I, II, ..., VII – have been adopted during the 80 years interval, each program containing 12 groups of either 8 or 6 star pairs.

On the whole, 535 stars, forming 257 latitude pairs and 24 refraction pairs, have been observed. Refraction pairs has been observed in the first six years of

the ILS activity just to investigate anomalous refraction and, due to their large zenith distance, they are not considered for deriving polar coordinates. Eight latitude pairs, centered around 6 and 18 hours of right ascension, are common to all seven programs.

Up to now, the main reference catalogue used in the ILS solutions is the Melchior & Dejaiffe (1969) catalogue (MD) to which are referred the declination and proper motion of all latitude pairs belonging to the first six programs; refraction pairs and 28 latitude pairs, belonging to program VII and observed after 1967, are referred to the Boss' General Catalogue (GC).

In the above cited reduction by IPMS, homogeneous declinations and proper motions have been adopted by applying suitable internal corrections to the MD and GC ones, obtained by internal comparison in and between the groups, so referring them to the MD mean bias of the correction of all the MD stars observed in programs I–VI. Due to the fact that MD was compiled in the system of FK4, the so improved positions are roughly that of the FK4 in the declination zone 20° to 60° .

3. COMPARISON OF THE ILS CATALOGUE WITH HIPPARCOS

In view of a re-reduction of the whole set of ILS latitude observations in the Hipparcos reference frame, a comparison of the adopted ILS declinations and proper motions (MD and GC) with the positions in the Hipparcos Catalogue was performed. We present here some preliminary results.

The comparison was made at same epoch B1950.0 by eliminating the systematic effect of different treatment of E-terms of aberration. In addition, the systematic differences between the FK5 and FK4 (Schwan 1988) were also taken into account for the MD stars.

In a first step we compared the corresponding values of each ILS star listed in the Hipparcos Catalogue, the number of which is 533 (433 MD + 100 GC including the refraction stars). The differences in declination $\Delta\delta_{\text{HIP}} = \delta_{\text{HIP}} - \delta_{\text{ILS}}$ and in proper motion $\Delta\mu'_{\text{HIP}} = \mu'_{\text{HIP}} - \mu'_{\text{ILS}}$ are plotted in Figure 2.

At first sight it can be noted that the differences HIP – GC are larger than the differences HIP – MD, apart from some sporadic MD values. The mean difference HIP – MD is -15 mas in declination and -0.8 mas/yr in proper motion. A systematic difference depending on right ascension, whose amplitude is about 39 mas in declination and 4.4 mas/yr in proper motion, is also fairly evident.

In a second step we considered the 255 star pairs (227 MD and 28 GC) including for each pair the IPMS internal corrections in declination $\Delta\delta_{\text{IPMS}}$ and in proper motion $\Delta\mu'_{\text{IPMS}}$ taken from the quoted work by Yumi & Yokoyama (1980). Refraction pairs were not considered in this step. The differences $\Delta\delta_{\text{HIP}} - \Delta\delta_{\text{IPMS}}$ and $\Delta\mu'_{\text{HIP}} - \Delta\mu'_{\text{IPMS}}$ are grouped in Figure 3.

The mean difference is 7.7 mas in declination and -0.8 mas/yr in proper motion. The systematic difference depending on the right ascension has in this case an amplitude of about 22 mas in declination and 2.4 mas/yr in proper motion.

In general, we can say that the agreement between Hipparcos-derived corrections and the IPMS internal ones is satisfactory. It should be noted that the set of the IPMS corrections is not completely homogeneous because many stars have been observed for a large time interval while other ones have been observed just for a few years.

Further work is in progress.

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