PRECESSIONAL PARAMETERS OBTAINED FROM BIASED DATA OF HIPPARCOS-FK5 PROPER MOTIONS

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ABSTRACT. The Hipparcos catalogue provides a reference frame in optical wavelength for the new ICRS. The differences in the system of proper motions of Hipparcos and the previous materialization of the reference frame, the FK5, are expected to be caused only by the combined effects of the motion of the equinox of the FK5 as well as the Luni-solar and planetary precession, but several authors have signaled the existence of an inconsistency for the proper motion differences of the FK5-Hipparcos with the Δp values corresponding to the Luni-solar precession as determined from VLBI and LLR It is a fact that the widely employed parametric models do not remove the bias in the random variables. The introduction of a non parametric method, combined with the inner product in L^2 over S^2 shows the necessity of removing the bias. The precessional formulas should be rearranged to be used in this case. When applying this model, the obtained values for the precession corrections are very consistent with the ones currently adopted by the IAU.

1. INTRODUCTION

The study of the proper motion differences of the FK5-Hipparcos with the Δp value corresponding to the Luni-solar precession as determined from VLBI and LLR has revealed an inconsistency which has been explained, for example, by Walter & Herring (2005) due to errors of the FK5 proper motions caused by the galactic rotational effects and by slightly biased Hipparcos proper motions; Zhu (2000) suggested that one of the reasons for these discrepancies could be the internal biased proper motion system of the FK5. The question of the study of how to deal with the real data when bias exist has been developed in depth in Marco et al. (2004), where we propose a modification of the usual model to study the rotation between catalogues in order to remove the bias in proper motions following a GLAD model:

$$\begin{gathered}\Delta\mu_\alpha \cos\delta = \Delta\dot{A} - \widetilde{w}_x \cos\alpha \sin\delta - \widetilde{w}_y \sin\alpha \sin\delta + \\ \widetilde{w}_z \cos\delta \\ \Delta\mu_\delta = \Delta\dot{D} + \widetilde{w}_x \sin\alpha - \widetilde{w}_y \cos\alpha\end{gathered} \tag{1}$$

This model is an auxiliary tool to deal with the data without trying to obtain any physical explanation

2. PRECESSION FROM HIPPARCOS AND FK5 PROPER MOTIONS

The angular rates of rotation spins w_x, w_y, and w_z allow us to obtain information about the Luni-solar precession according to the relationships (Fricke, 1977):

$$w_x = 0 \tag{2}$$
$$w_y = -\Delta p \sin\varepsilon \tag{3}$$
$$w_z = \Delta p \cos\varepsilon - (\Delta\lambda + \Delta e) \tag{4}$$

Δp is the Luni-solar precession, $\Delta\lambda$ is the planetary precession and Δe is the fictitious motion of the equinox Notice that w_x, w_y, and w_z represent the spins if we suppose that there is no bias in the data. We can not apply these formulas due to the fact that our model (1) contains two additional parameters to remove the bias, so the angles obtained are not exactly these ones. An homogeneous net of points over the whole sphere makes possible the use of statistic and numerical methods in order to contrast the

	$\widetilde{w}_x$	$\widetilde{w}_y$	$\widetilde{w}_z$	$\Delta\dot{A}$	$\Delta\dot{D}$
Statistical	0.3948	-0.5931	-2.1073	1.0029	0.2031
Numerical	0.4083	-0.5741	-1.9707	0.8769	0.2735

Table 1: Spin values for the FK5-Hipparcos proper motions comparison. Statistical stands for the direct application of (1) over 1277 common stars of Hipparcos and FK5; Numerical stands for the independent verification explained in Marco et al. (2004)

results: using KNP (a Kernel non parametric method, see Wand & Jones (1995) and $\Phi_y = -cos\alpha sin\delta$ and taking into account that $(KNP, Y_{21}) = w_y(\Phi, Y_{21})$ (see Marco et al. 2004), where (,) represents the usual inner product and $Y_{21} = 3sin\alpha sin\delta$ element of the functional basis of L^2 in S^2 functions (see for a further development of this method)

Using SH_2 (SH_2 denotes the development in spherical harmonics truncated at second order) and Φ_y and taking into account that $c_21(Y_21, Y_21) = w_y(\Phi_y, Y_21)$, (see Marco et al. (2004) where c_{21} represents the coefficient for the Y_{21} function in the development. So, we applied a KNP model and then we used formula (20) from Marco et al. (1996) over the points to numerically obtain the parameters (which are listed as 'numerical' in Table 1) At this stage, it is not possible to obtain the precessional parameters directly from these values and (3), (4) and (5). Instead, we need to obtain the 'inducted' values for these angles. As showed in Marco et al. (1996), the 'inducted' value w_z as deducted from the GLAD model is:

$$w_y = \Delta\dot{D} - \frac{\widetilde{w}_z sin(2\varepsilon)}{2} \tag{5}$$

As far as we have defined the residuals over the whole sphere it is possible to check the accuracy of the w_y value applying other independent methods. To this aim we use the KNP and the SH_2 methods to obtain a w_y value, from which we easily obtain Δp then, taking into account the evident relationship $w_z = \Delta\dot{A} + \widetilde{w}_z$ we obtain w_z and finally from (5), we compute Δe

The resulting values obtained using the statistical and the numerical methods are listed in Table 1.

3. CONCLUSIONS

The values for the correction of precession obtained from the GLAD model as inducted by a previous global KNP model are in very good agreement with the optimum values as obtained from VLBI and LLR, on the contrary of what happens when bias are not considered. The use of a model that not considers bias in this case is not adequate, and the conclusions derived from it are erroneous.

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4. REFERENCES

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