INFLUENCE OF SYSTEMATIC DIFFERENCES OF FK4 ON DETERMINING EARTH ORIENTATION PARAMETERS

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ABSTRACT. In this paper the corrections of positions and proper motions (J2000) of FK4 were obtained. For different kinds of observational methods the formulae of calculating the influence of systematic differences of FK4 on time and latitude determinations were derived. The influence of systematic differences on the universal time and polar coordinates (1980-1988) of Chinese Joint System (CJS) and the global optical solution of earth orientation parameters (1987-1988) were calculated and their external precisions referred to BIH or IERS were also re-estimated.

1. Introduction

Just because till now only about 100 radio sources have the positions with the precision of 1 mas a project of determining the positions of 400 or more radio sources is being carried out over a five year period starting from July 1987 (Johnston,R.J. et al. 1987). It is known that the connection between the radio and optical reference frame is being studied so the optical reference frame FK5 is still used in many research fields.

The stellar positions and proper motions of FK4 were used during 1962-1988 for time and latitude determinations. According to the observational status, the influence of systematic differences of FK4 on the universal time and polar coordinates (1980-1988) of Chinese Joint System (CJS) and the global optical solution of earth orientation parameters (1987-1988) should be considered.

2. Determinations of Systematic Differences Between FK5 and FK4

As it is known the positions and proper motions of FK4 are referred to the equinox and equator of B1950.0. By means of the formula (McCarthy, D.D 1989) those are changed to referred equinox and equator of J2000.

The analytical method (Bien, R. et al. 1978) was adopted for calculating the systematic differences of positions and proper motions, corresponding epoch being J2000, between FK5 and FK4. The positions and

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proper motions of 1535 and 1987 stars, corresponding to fundamental and supplement stars of FK4, were used to calculate the systematic differences separately.

3. Influence of Systematic Differences of Catalogue On Time and Latitude Determinations

There are several methods for time and latitude determinations. The influence of catalogue systematic differences for different methods are as follows:

transit	$\Delta u = \Delta\alpha$	
zenith distance measured	$\Delta\phi = \Delta\delta$	(1)

For equal altitude method if the observing condition is assumed that the stars are homogeneous distribution along the equal altitude and are observed each 10^{o} except $\pm 15^{o}$ around meridian $\Delta u = \Delta\alpha$, $\Delta\phi = \cos z\, \Delta\delta$, where $|\phi| <= 40^{\circ}$.

4. Influence of Systematic differences of FK4 On Determining Earth Orientation Parameters

There are several independent joint universal time system such as BIH (before 1988), Standard Time of USSR and Chinese Joint System (CJS).

The influence of systematic differences of FK4 on CJS was calculated during 1980-1988.Because the observing range of declination is different for transit, astrolabe etc. the systematic differences are interpolated by using the interpolating factors of declinations such as $\phi - 10^{\circ}$, $\phi - 5^{\circ}$, ϕ , $\phi + 5^{\circ}$, $\phi + 10^{\circ}$ The interpolating factor in right ascension will be $0^{h}.5$, $1^{h}.5$... etc. according to the observing interval of the group. The systematic difference of catalogue for the observing group is obtained from all systematic differences, which are reduced the proper motions, in observing range of declination and right ascension.

By using the pratical weight, which equals $\sqrt{N}$ P, the influence of systematic differences of FK4 on the universal time of CJS during 1980-1988 were obtained and drawn in Fig.1. After reduction of the systematic differences of FK4, the precisions referred to BIH and IERS were re-estimated and are listed in Table 1.

It can be seen that the precision of universal time of CJS in 1988 is not improved because of the less observations made with seven instruments.

By using the Orlov method the instantaneous coordinates are obtained with the observations of single station. The instantaneous polar coordinates referred to the mean pole of the epoch were used in CJS. As we know the relation between stationary polar coordinates and the pole coordinates of epoch is $X = Xo + X1$, $Y = Yo + Y1$,where Xo and Yo are the mean pole coordinates of epoch in 1968.0 (Polar Motion Collaboration Group 1976). For Orlov method X1 and Y1 are the sum of the annual and Chandler components, i.e. $X1 = Xa + Xc$ and $Y1 = Ya + Yc$, in which Xa and Ya are calculated with the stationary formulae. Therefore, the influence of systematic differences of FK4 on $\Delta X1$ and $\Delta Y1$ are the same as that on ΔXc and ΔYc.

$$\Delta\phi_C = \Delta X_C \cos\lambda + \Delta Y_C \sin\lambda \qquad (2)$$

where $\Delta\phi_C$ is the influence of systematic differences of FK4 on the latitude determinations. After solving the observing weighted equation (2) ΔXc and ΔYc, i.e. $\Delta X1$ and $\Delta Y1$, are obtained each month.

In 1976 there were 41 instruments adopted to determine the mean polar coordinates of epoch 1968.0. Since 1983 there were only 26 instruments, such as Ottawa (PZT),Quito (AST),Tianjin (ZTL-180) etc. to continue observations. It is assumed that the observations are symmetric to meridian of the station and the clear night are homogeneous for whole year and month. The influence of systematic differences of FK4 on Xo and Yo were calculated with the following formula.

$$\Delta\phi_{\Delta\delta} - \Delta\phi_C = \Delta X_0 \cos\lambda + \Delta Y_0 \sin\lambda \qquad (3)$$

where $\Delta\phi_{\Delta\delta}$ are the influence of systematic differences on latitude determinations measured with 26 instruments and $\Delta\phi_C$ are calcalated by formula (2). The values of ΔX and ΔY are shown in Fig.1.

Since 1988 Shanghai Observatory was assigned as an analysis center of optical technique by IAU commission 19(jin Wenjing and Liao Dechun, 1989). The global solution of earth orientation parameters,in which the influence of systematic differences of FK4 was taken into account, was calculated. The influence of those on earth orientation parameters are shown in Fig. 2.

5. Conclusion

The influence of systematic difference of FK4 on the previous results of time and latitude determinations should be considered.

After reduction of systematic difference of FK4 the values of earth orientation parameters, whether the universal time of CJS or the global solution, are close to those of BIH and IERS. The improvement of precisions in the universal time of CJS is slightly better than that in the global solution of earth orientation parameters because of the reduction of influence of catalogue on time and latitude determinations measured by the optical instruments, which are located at the narrow longitudinal region in China.

6. References

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Table 1 Precisions of Universal time of CJS Unit: 0ˢ001

	original precision		precision after considering the systematic difference	
	K	ε	K	ε
1983	-4.6	±2.1	-3.4	±2.0
1984	-4.9	2.8	-3.7	2.4
1985	-4.4	3.0	-3.2	2.5
1986	-2.4	2.4	-1.3	1.9
1987	-2.2	2.3	-1.1	1.7
1988	-3.5	2.0	-2.4	2.7

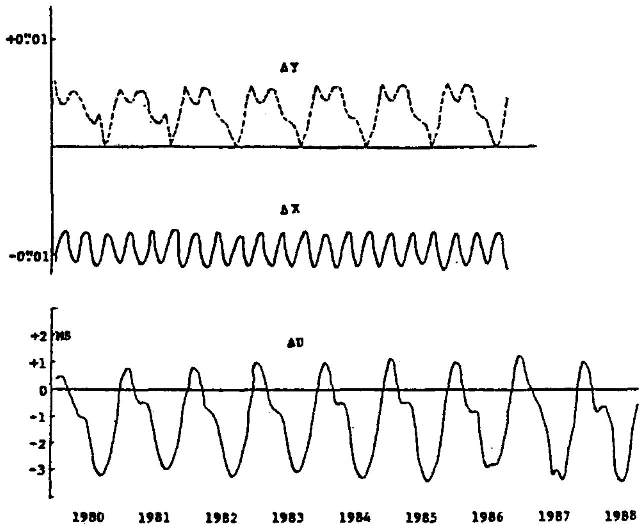

Fig. 1 The influence of FK4's Systematic Differences on Earth Orientation Parameters of CJS during 1980 -- 1988

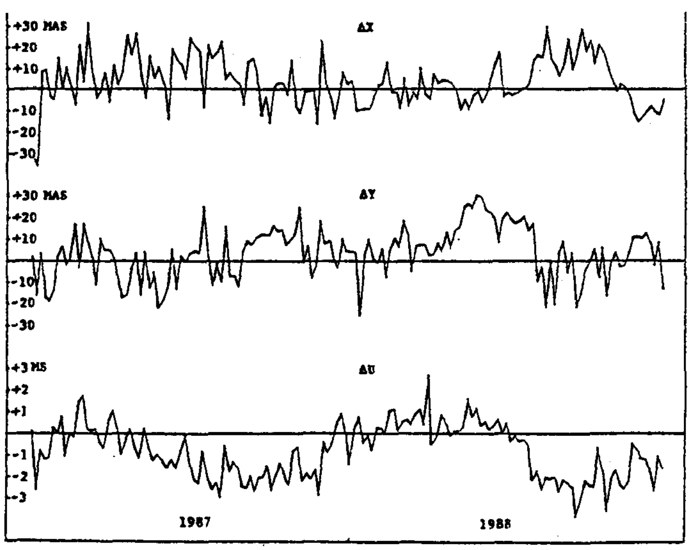

Fig. 2 Influence of Systematic Difference of FK4 on Global Solution of EOP

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