An Optimal Identification of Clock Behaviour Model for VLBI

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1. Introduction

The accuracy of VLBI measument has reached centimeters(Carter et al.,1985). But in VLBI observation the observable are broken sometimes because of the variations of the clock phases or frequencies. This is the first problem met in VLBI data processing.

Recently, the interactive mode is adopted to determine the intant of the clock discontinuities and the clock behaviour model of the seperate sections. By using this mode the results will not only be effected by personal cause (Robertson,1975), but also it takes a lot of computer time.

In this paper, we will discuss the estimates of clock models and the discontinuities in VLBI data processing by information criteria in order to improve the results and the procedure of VLBI data processing.

2. The Optimal Estimate Method of Clock Behaviour Model

According the physical character of atomic clock, the clock behaviour model in one session of VLBI can be described as

$$OCt = \sum_{j=1}^{L} (a_j + b_j t + c_j t^2) + \mathcal{E}_t^j \qquad (1)$$

where t is the argument of time, $\mathcal{E}_t^j$ is the noise in clock. When L=1, it means that the clock has no discontinuities in this session and only one clock behaviour model is needed. If L$\geqslant$2, the clock has some variations and two or more models are needed to describe the clock behaviour in this session.

Then the followed Information Criteria presented by Akaike (1973) is adopted:

$$AIC(\hat{B},\hat{T},\hat{K}) = \min \sum_{j=1}^{L} (Nj'Ln(RSS(Kj)/Nj')+2(Kj+1)) \quad L=1,2,...,Lm \qquad (2)$$

$\hat{B},\hat{T}$ and $\hat{K}$ are the optimal estimates for the number, the instant of the clock discontinuities and for the orders of clock behaviour model respectively. Where Lm is the maximum number of clock behaviour model existed possiblly in the observations. RSS is the sum of the residural square after fitting jth model and Nj' is the freedom for jth model.

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From the formula (2), the optimal estimates of B, T and K must simultaneously satisfy the condition of minimum of AIC.

3. The Results

In addition to the simulated data, the observations data of single baseline in POLARIS project in 1983 are also selected to estimate the B,T and K, then to compute the site coordinates. The estimates of clock bahaviour models are listed in Table 1 and Table 2 with that ones obtained by manual mode in NGS. The results for the code of OC137 and OC144 are shown in Fig.1.

Table 1. the Estimates of Clock Behaviour Models
by AIC and Manual

		AIC				Manual			
Code	Date	k1	k2	instant of disc.	RMS	k1	k2	instant of disc.	RMS
	y m d			d h m	ns			d h m	ns
OC122	1983 8 1	1	2	2 1 24	±.511	2	2	2 6 20	±.544
OC137	10 22	2	2	23 10 16	.351	1	2	23 10 20	.378
OC144	11 26	2	1	27 10 1	.211	2	2	27 6 0	.216
OC146	12 6	2	1	7 5 42	.205	2	2	7 6 15	.205
OC147	12 11	2	1	12 8 56	.296	2	2	12 4 15	.303

Table 2. Differences of the Site Coordinates caused by Estimates
of the Clock Behaviour Models with AIC and Manual

Code	X (m)	Y (m)	Z (m)
OC122	-0.0144	0.1043	-0.0831
OC137	-0.0013	-0.0265	0.0291
OC144	-0.0031	-0.0074	0.0082
OC146	-0.0030	-0.0372	0.0312
OC147	-0.0011	-0.0050	-0.0024

The numbers of discontinuities obtained by AIC and Manual are compared as shown in Table 3.

Table 3. the Effects on Site Coordinates from the Numbers of
Clock Discontinuity Estimated by AIC and Manual

Code	Date	number of clock disc.		DX	DY	DZ
	y m d	AIC	Manual	(m)	(m)	(m)
OC104	1983 3 28	1	2	0.0019	0.0320	-0.0390
OC113	5 31	1	2	0.0209	-0.2380	0.2064
OC119	7 11	0	2	-0.0058	-0.0433	0.0433
OC130	9 17	1	0	0.0042	-0.0238	0.0192
OC151	12 31	1	0	0.0010	0.0252	-0.0213

The results obtained by AIC are different a few centimeters from that ones by interactive mode generally, and are approximately similar to the results of Clark et al.(1985). But the differences will reach about 10 to 20 centimeters sometimes when the observations are more dispersive. It should not be negletcted in VLBI survey with so high accuracy.

By using AIC mode, the identification of clock models will base on a rigorous mathematical criterion and the effects on the results of VLBI from personal cause will essentially be elimited. Furthermore it will improve the efficiency of VLBI data processing because the clock model is automatically selected by computer.

4. Acknowledgements:

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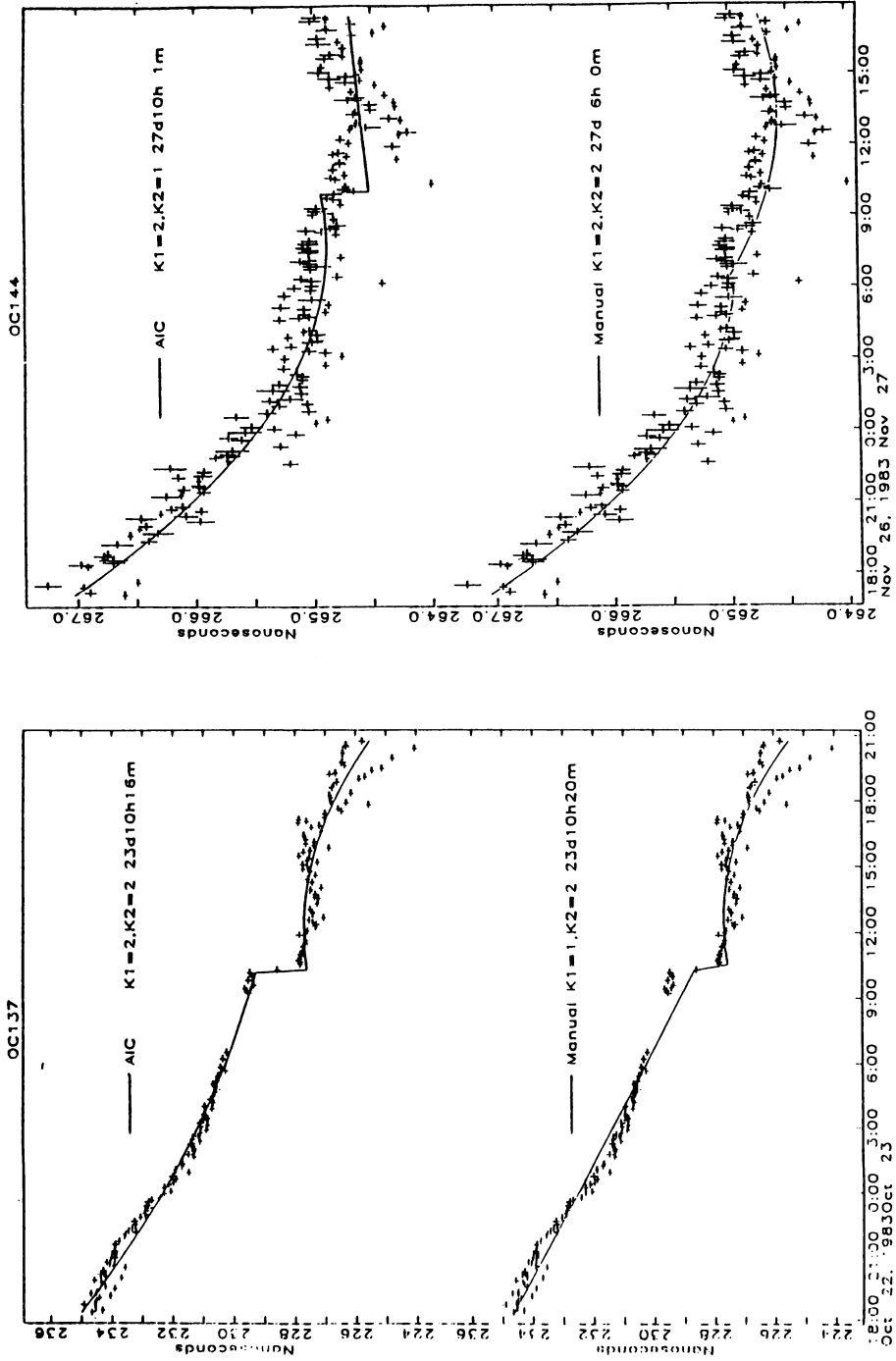
Fig. 1. The estimates of clock behaviour models for VLBI observation with code of OC137 and OC144 by AIC and Manual methods. The time and K1,K2 represent respectively the broken time and the orders of models.