SLR Data Automatic Preprocessing

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Outline

- Introduction
- Satellite Prediction
- Observation Data Preprocessing
- Conclusions

1.Introduction

Principle of SLR

LAGEOS

ERS-2

TOPEX

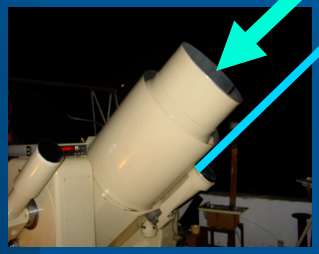
R=C×t/2

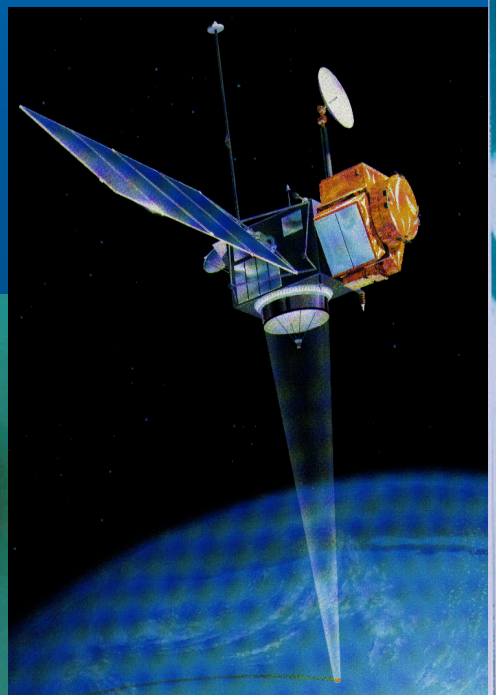
C: Velocity of light

T: Round-trip time

R: Range

Cooperate Object





The work of Beijing SLR station(1)

- **Obtained satellite passes: to 30, Jun, 2008**

Beijing:1850; San_Juan:5255

Site Information			Data Volume									Data Quality		
Location		Station ID	LEO pass Tot	LAGEOS pass Tot	High pass Tot	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Minutes of Data	Cal. RMS	Star RMS	LAG RMS
Baseline			1000	400	100	1500								
1	Yarragadee	7090	9638	1988	1373	12999	204021	25377	12731	242129	166320	4.7	8.9	9.4
2	San_Juan	7406	5255	1082	1303	7640	84520	13173	8659	106352	92649	13.1	13.9	15.2
3	Mount_Stromlo_2	7825	5297	1274	484	7055	70033	12860	3586	86479	66201	3.1	4.2	5.8
4	Graz	7839	4651	740	519	5910	92498	8291	4272	105061	61353	1.9	3.4	5.2
5	Wettzell	8834	4094	1033	411	5538	43417	7905	1727	53049	38825	4.6	12.1	19.1
6	Herstmoncex	7840	3881	888	374	5143	61069	10396	1582	73047	44178	7.3	12.1	15.4
7	Changchun	7237	3954	593	570	5117	44205	4953	2970	52128	37099	13.0	13.8	16.7
14	Beijing	7249	1850	296	194	2340	27806	2836	1489	32131	21875	7.0	14.4	25.9
	Borowiec	7811	79	22		101	1133	214		1347	763	15.9	18.1	26.0

(From: http://ilrs.gsfc.nasa.gov)

The work of Beijing SLR station(2)

- **Integrate SLR system**
- **Hardware:**

  change fuel laser to diode pumped laser
- **Software:**

  1) Satellite prediction based on CPF

  2) Raw SLR data preprocessing (Preprocessing)

Introduction of SLR data preprocessing

- 1) Satellite prediction
  - producing schedule
  - generating tracking file
- 2) tracking data acquire
- 3) preprocessing (Manual!/Automatic?)
  - noise eliminated
  - generating NP

Reliability and efficiency are two necessary factors taken into account in automatic preprocessing method.

2. Satellite prediction

- **Introduction to CPF**

(1) CPF(Consolidated Prediction Format)

(2) Provide a standard ephemeris format

(3) Service for SLR and other astronomy calculation

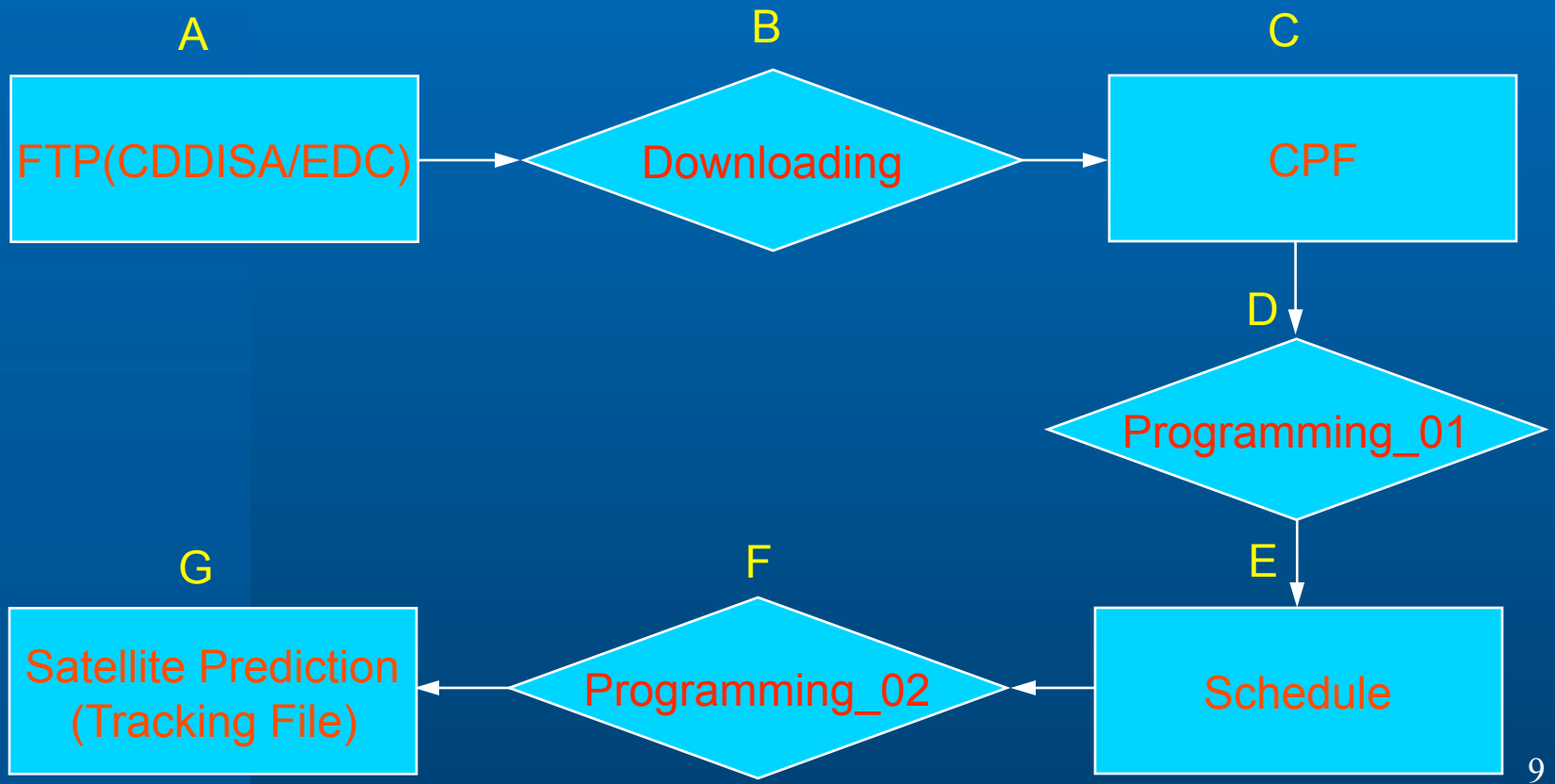
(4) Make complex work become easy

Features of CPF

- **A. Simply Calculation**
  - (1) Time system: UTC No Time System Transition
  - (2) Coordinate system: Geocentric coordinate
  - (3) Calculate: Interpolation No using EGM and integral
- **B. High Precision**
  - (1) Azimuth and Elevation direction
  - (2) Range direction
- **C. Multiple Information**
  - (1) Multiple target: earth satellite, Lunar, Apollo (other stars??)
  - (2) Multiple resources: hts, jax, sgf, gfz, cod
  - (2) Multiple records: position, correction etc.

How to use CPF(1)

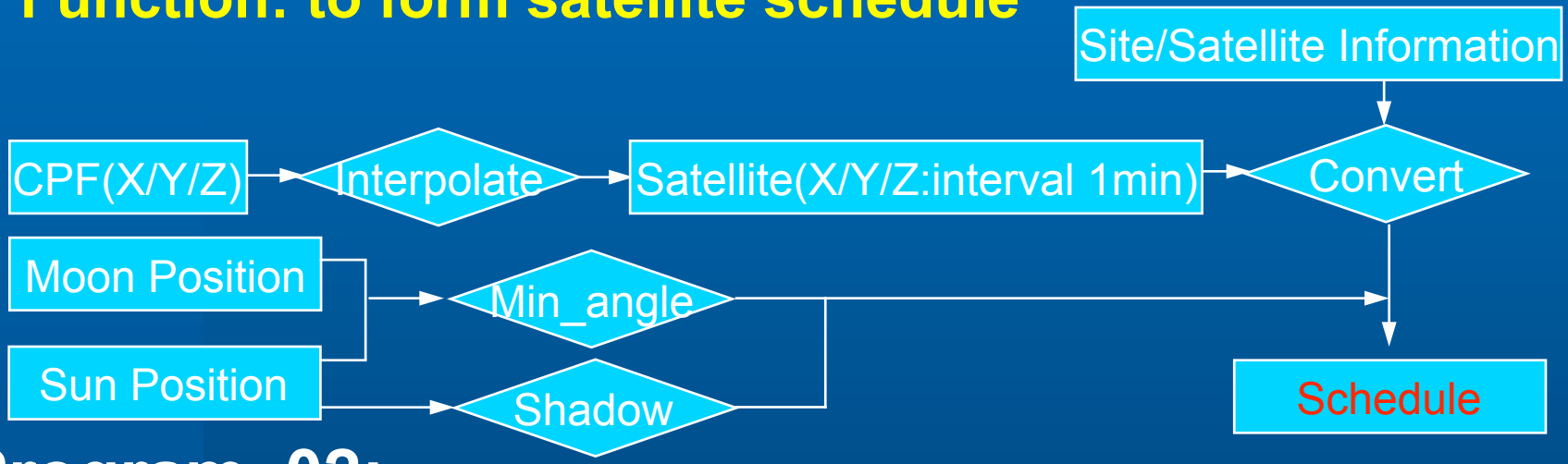
- **Flow chat**



How to use CPF(2)

- **Program_01:**

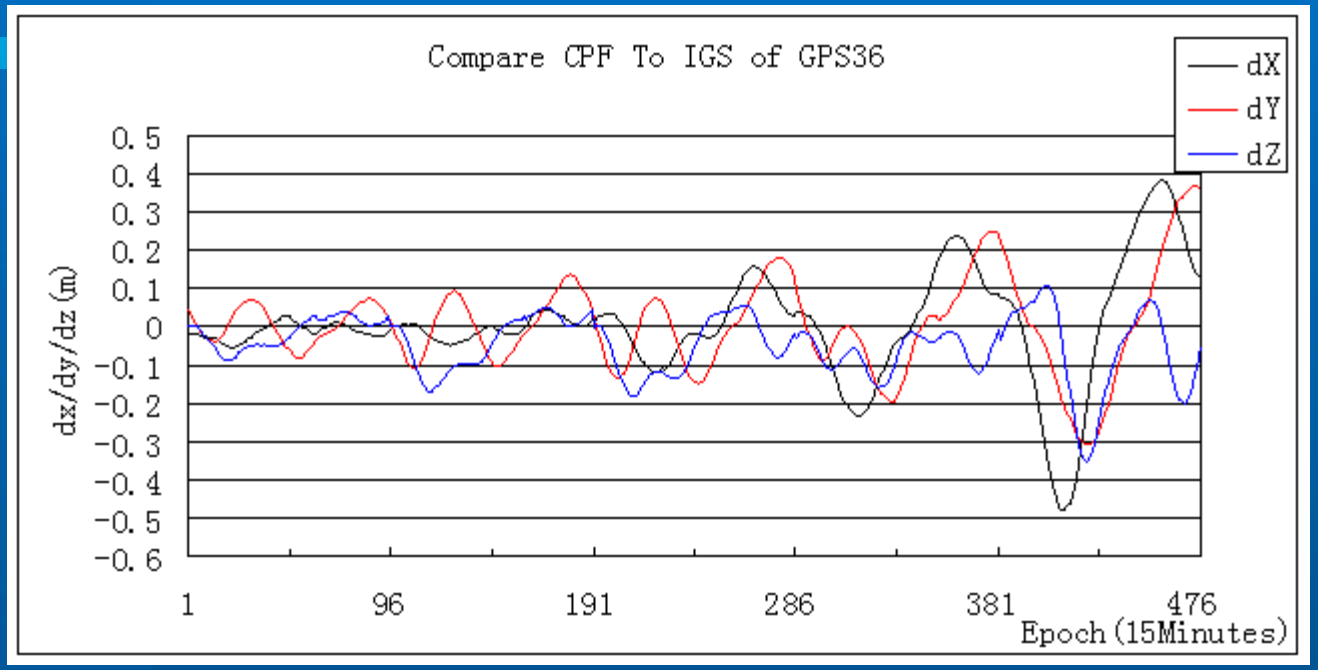
  Function: to form satellite schedule



- **Program_02:**

  Function: to generate satellite tracking file

Compare the CPF of GPS36 to IGS



Standard Deviation

The two days(Epoch:1~192):

dX=± 2.36cm; dY= ± 6.30cm; dZ= ± 5.58cm

All five days(Epoch:1~480):

dX=± 14.21cm; dY= ± 12.37cm; dZ= ± 8.09cm

3. Observation Data Preprocessing

- **Objects of preprocessing**

  1) eliminate noise from raw data

  2) form Normal Point data

- **Principal of preprocessing**

  In theory, satellite orbit is sequent, so the rang of SLR observation and its change should be continuous.

Methods of preprocessing

1) Manual

— please rub out the point that you think it is noise.

Intuitive/Simple/Reliabile?/Inefficient/Tired

Now: Low repeat frequency

2) Automatic

— based on program control and let compute do it.

Arithmetic programmer/Reliable?/Efficient/Comfortable

Future: High repeat frequency

• Requirements of automatic preprocessing

1) Judge the raw data good or not: TB, RB and RMS

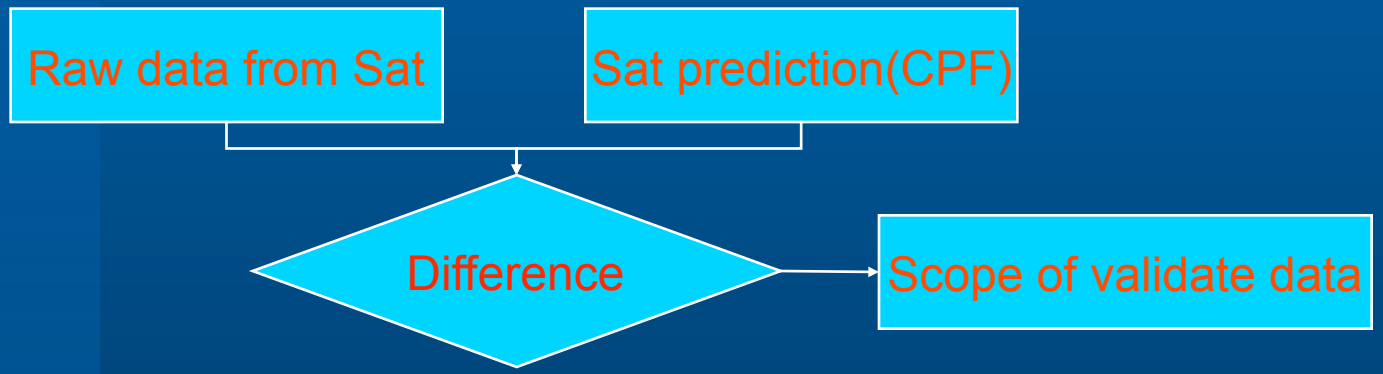
2) Reliable: Alarm Function, if data quality is not very good, the program can tell user.

3) Efficiency: as more data processed as possible

Analysis the prediction

SLR tracking work is based on satellite prediction (CPF), so the quality of CPF is one determinative on Data preprocessing.

- **Distance difference scope:**

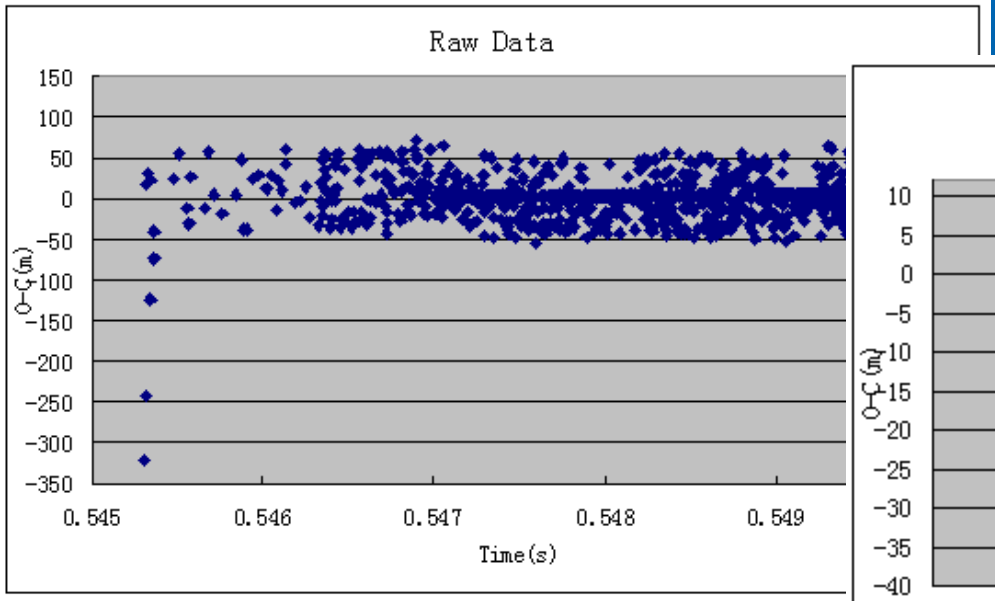


The Scope of difference

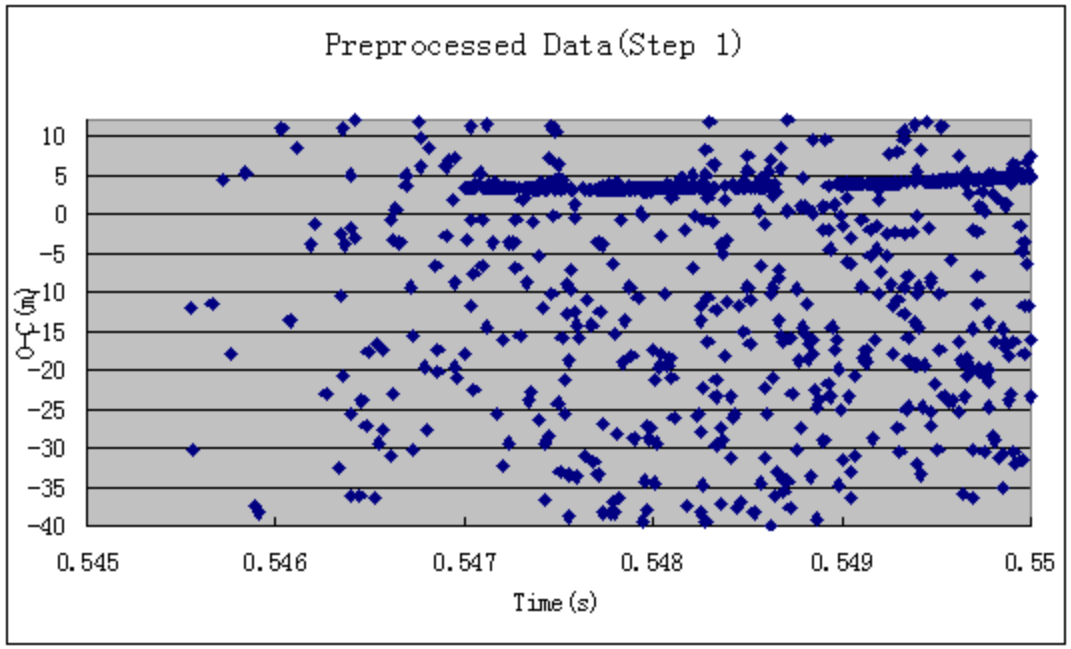
Satellite		1st CPF	2nd CPF	3rd CPF	4th CPF	5th CPF
Ajisai	Max(m)	-1.5663	-1.3967	-1.0922	-0.3666	1.1244
	Min(m)	-18.4788	-18.5705	-18.8610	-19.8692	-21.3443
BeaconC	Max(m)	-2.6093	12.1115	43.7220	97.1085	205.1192
	Min(m)	-20.1034	-36.1673	-64.3542	-109.8722	-211.3473
Giovea	Max(m)	-14.3309	-14.4086	-14.8789	-12.4205	-12.1184
	Min(m)	-19.0102	-19.8698	-20.1023	-21.4351	-23.5770
Glonass95	Max(m)	-9.3410	-8.4387	-4.9057	-2.1750	
	Min(m)	-22.4638	-23.4744	-25.0497	-28.3400	
GraceA	Max(m)	2.9603	140.1154			
	Min(m)	-27.8360	-172.7061			
Lageos1	Max(m)	-9.3552	-9.4068	-9.3824	-9.3074	-9.3569
	Min(m)	-16.8682	-16.8693	-16.8860	-16.9625	-17.0553
Starlette	Max(m)	-4.9380	-2.9942	1.8247	10.4722	21.2068
	Min(m)	-20.5069	-21.6327	-25.6805	-34.0793	-45.1276

Method of Automatic Data preprocessing(1)

- **Step1: Based on CPF scope**



[-36,12]



Method of Automatic Data preprocessing(2)

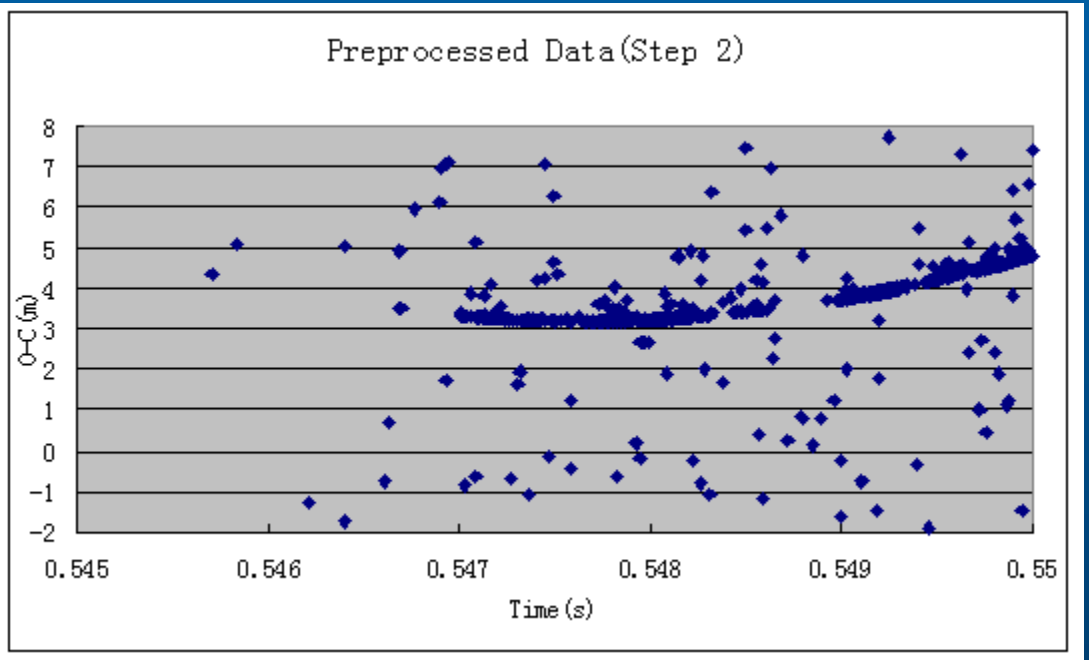
- **Step 2: Comparting on O-C**

$$\frac{Max(o-c)-Min(o-c)}{100}=\Delta R$$

$$Num(i)\geq All/100,\ i=1,2,\ldots,k_1,\ R\max\ New=Max(0-c)-k_1\times\Delta R$$

$$Num(i)\leq All/100,\ i=100,99,\ldots,k_2,\ R\min\ New=Min(0-c)+(100-k_2)\times\Delta R$$

[Rmin,Rmax]



Method of Automatic Data preprocessing(3)

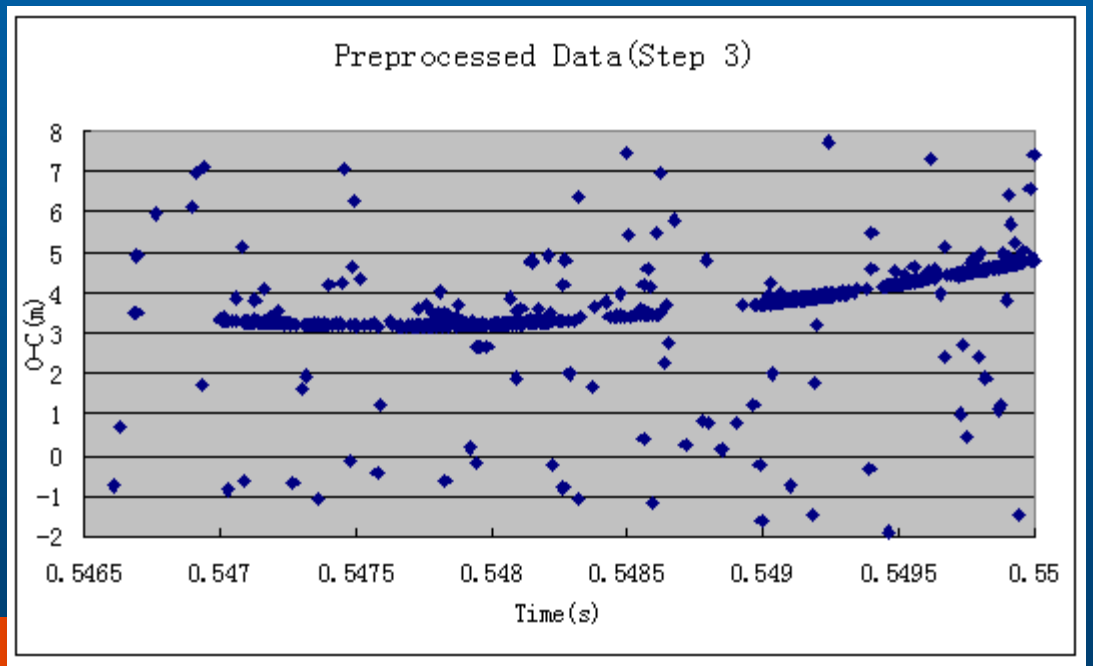
- **Step 3: Comparting on Time**

$$\frac{TStart - TEnd}{100} = \Delta T$$

$$Num(i) \geq All/100,\ i = 1,2,\ldots,k_1,\ TMax = TEnd - k_1 \times \Delta T$$

$$Num(i) \leq All/100,\ i = 100,99,\ldots,k_2,\ TMin = TStart + (100 - k_2) \times \Delta T$$

[Tmin,Tmax]



Method of Automatic Data preprocessing(4)

- **Step 4:**
  - —**Iterating Step2 and 3**
  - —**polynomial computing**
  - —**Form NP**

Conclusions

- **About Prediction**

  (1) ephemeris' precision more high

  (2) convenient using than before

- **Automatic preprocessing**

  (1) single to noise rate

  (2) not very mature and still lots work to do

Thanks!

谢谢！