Assessment of SLR observation performance using LAGEOS data

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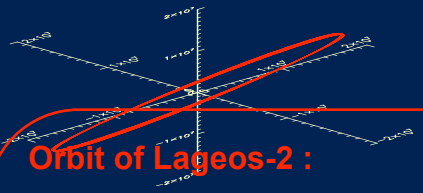
Outline

- Introduction
- Satellite properties
- Data processing methods
- Comparison of gravity field models
- Statistics of station observation
- Short-arc POD
- Assessment of station coordinates
- Summary

Introduction

- As a productive station, Changchun (7237) has provided large numbers of SLR observation data with moderate precision for more than 20 years. It has made great and continuously efforts in SLR equipment and technology.
- How to sufficiently make use of SLR data, and resource of experiential staffs, is an important issue for our future development.
- From the beginning of 2008 on, we have realized routine short-arc POD (precision orbit determination) and residual analysis on SLR data of LAGEOS-1/2, which is publicized on our website (www.cho.ac.cn) and is updated around once a week.
- What we can do using POD results, how to apply them in relevant geodynamic and geophysical problems, how to combine them with our observational duty, need seriously consideration.
- In this report, we'll present preliminary results and application of our SLR POD work, especially to LAGEOS.

Satellite properties



Orbit of Lageos-2 :

Name	LAGEOS-1	LAGEOS-2
ID	7603901	9207002
Mass	411 kg	
CM offset	0.251 m	
cross section	0.283 m^2	

Time span : 1200 days (Mar,1,2005 to Jun,12,2008)

Data processing methods

- Reference Coordinate System

Inertial	J2000.0
Terrestrial	ITRF2000
Precession	IAU1976
Nutation	IAU1980

- Measurement model

Plate tectonic motion	NNR-NUVEL1
earth solid tides	
rotational deformation	
ocean tide loading	CSR4.0
Tropospheric refraction	Marini/Murry model

Data processing methods

- Dynamical Model

earth gravity field	JGM-3 30*30
n-body perturbation	JPL ephemerides DE403 (sun/moon)
ocean tide model	CSR4.0+TEG4
relativistic correction	1-body
solar radiation pressure	conical
earth radiation and albedo	
thermal radiator (y-bias)	
empirical drag	
empirical RTN acceleration	

Data processing methods

- Estimated Parameters
  - satellite state vector (3-position & 3-velocity)
  - empirical drag coefficients
  - solar radiation pressure coefficients
  - earth radiation parameters
  - empirical acceleration R/T/N
  - earth rotation parameters (xp,yp,dut1/dt)

- Numerical Integration

Integrator	Krogh-Shampine-Gordon
step length	fixed-step, 150s

ILRS network

Comparison of gravity field models

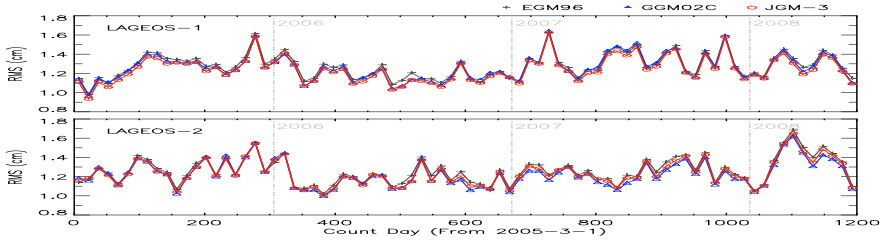
Gravity models :

EGM96 (IERS2003 recommended)

GGM02C (GRACE & terrestrial)

JGM-3 (IERS1996 recommended)

Arc length = 15 days



Comparison of gravity field models

Absolute value (m) of orbital precision:

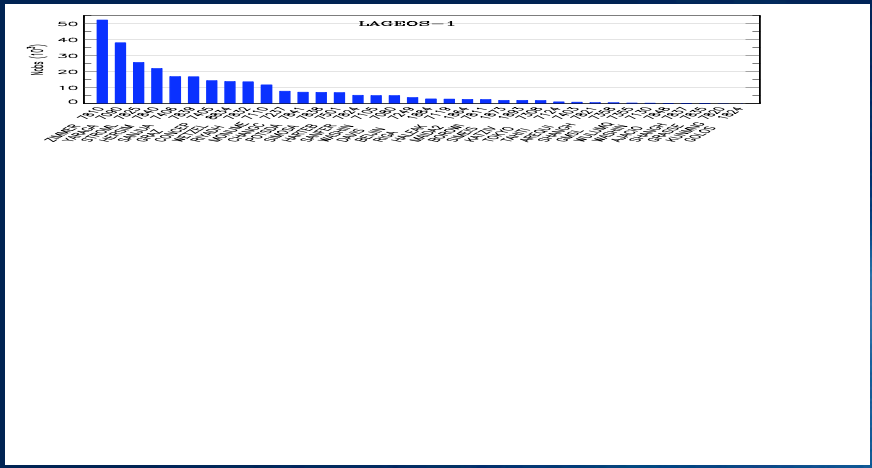
	RMS (EGM)	RMS (GGM)	RMS(JGM)
LAGEOS-1	0.012764	0.012607	0.012416
LAGEOS-2	0.012571	0.012258	0.012371
Mean	0.012667	0.012432	0.012393

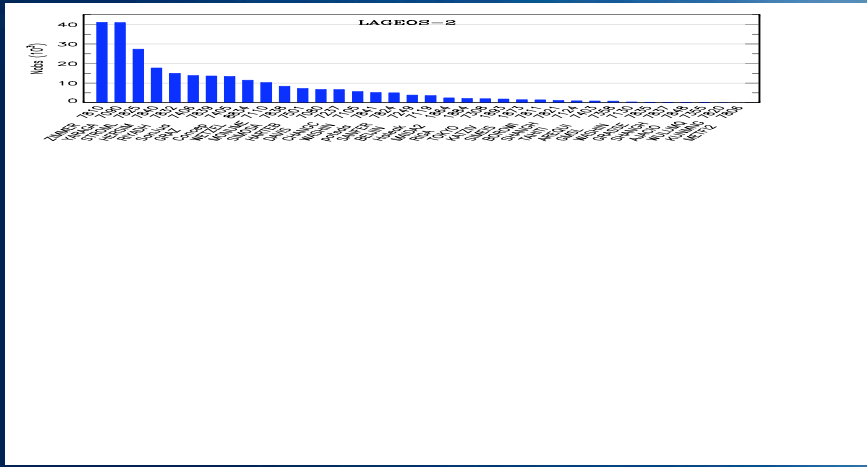
Relative value of orbital precision:

	RMS (EGM)	RMS (GGM)	RMS(JGM)
LAGEOS-1	1.0280	1.0154	1.0000
LAGEOS-2	1.0167	0.9909	1.0000
Mean	1.0221	1.0031	1.0000

Statistics of station observation

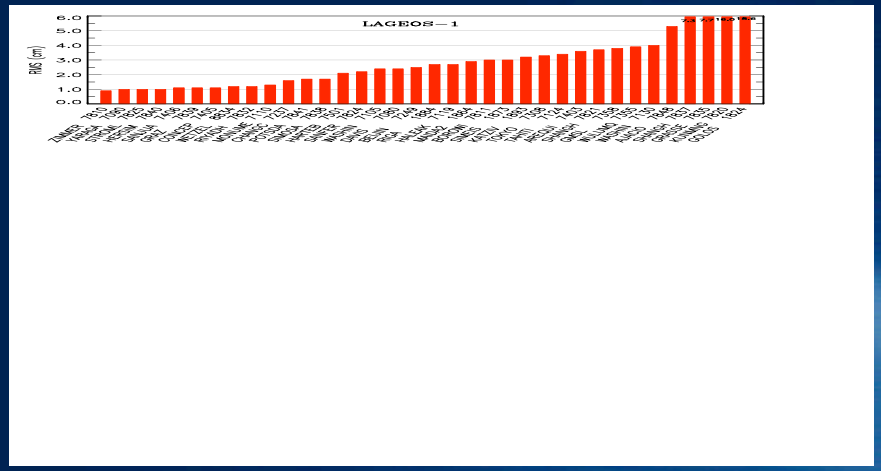
Quantity of observation

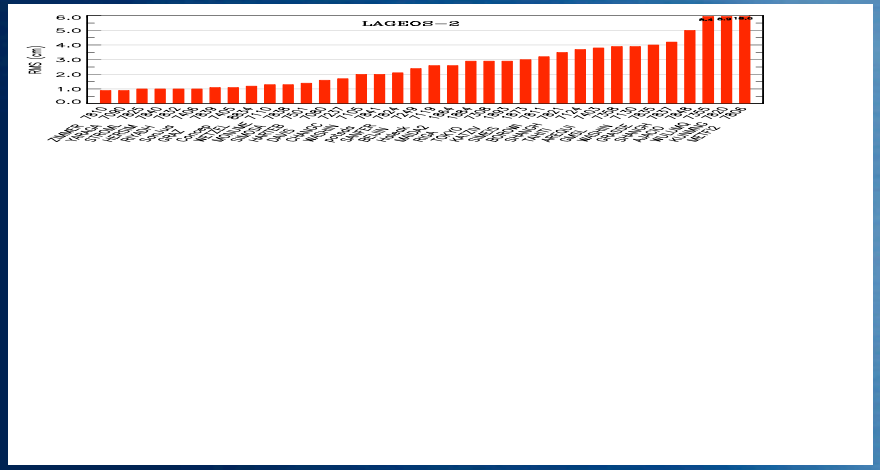




Statistics of station observation

Quality of observation





Statistics of station observation

LAGEOS-1 :

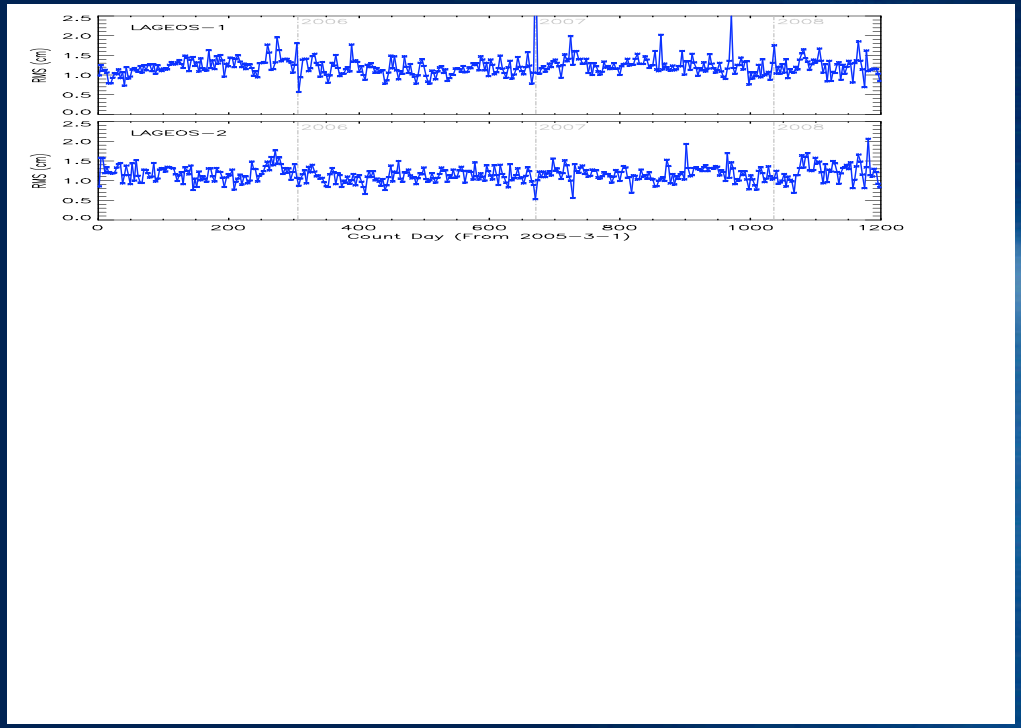
S_ID	Nobs	WRMS(cm)
7090	38066	0.9
7810	52294	1.0
7839	16817	1.0
7110	11729	1.0
7840	22045	1.1
7105	5110	1.1
7835	166	1.1
7080	5078	1.2
7848	189	1.2
7825	25841	1.3
7237	7836	3.3
7406	17004	3.7
7821	759	3.8

LAGEOS-2 :

S_ID	Nobs	WRMS(cm)
7090	40969	0.9
7839	13635	0.9
7810	41128	1.0
7840	17739	1.0
7110	10277	1.0
7105	5714	1.0
7835	217	1.1
7848	117	1.1
7080	6735	1.2
7825	27355	1.3
7237	6718	3.9
7406	13884	3.9
7821	1157	4.2

Short-arc POD

Arc length = 3 days



LAGEOS-1

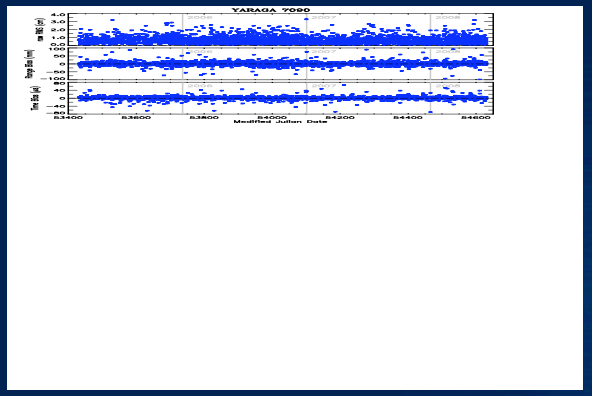
Mean of RMS = 1.22 cm

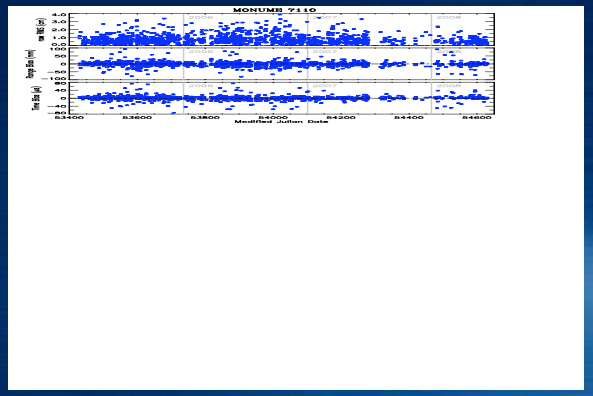
LAGEOS-2

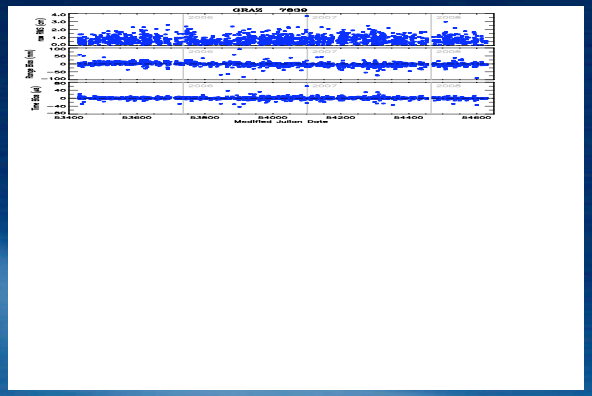
Mean of RMS = 1.17 cm

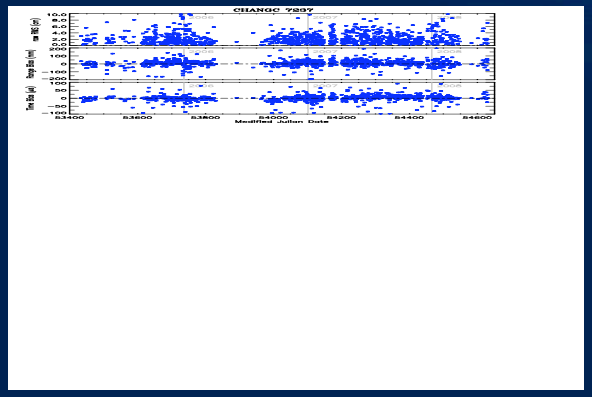
Short-arc POD

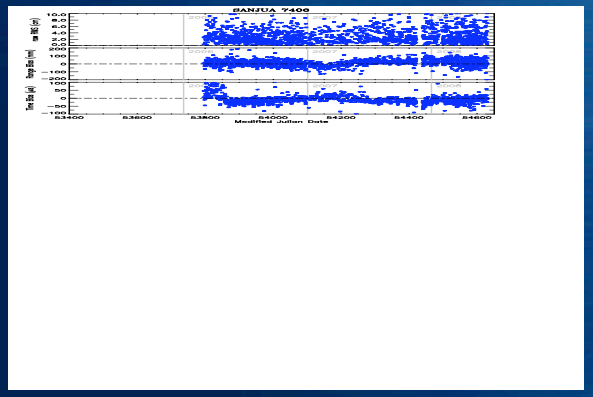
Station performance (LAGEOS-1)

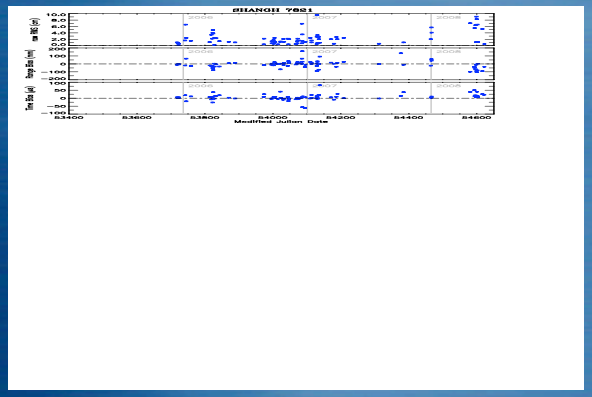






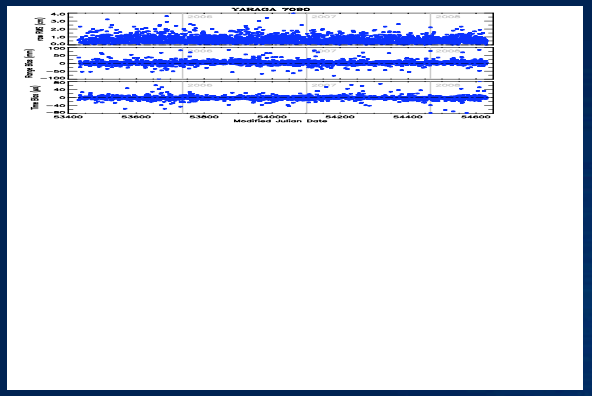


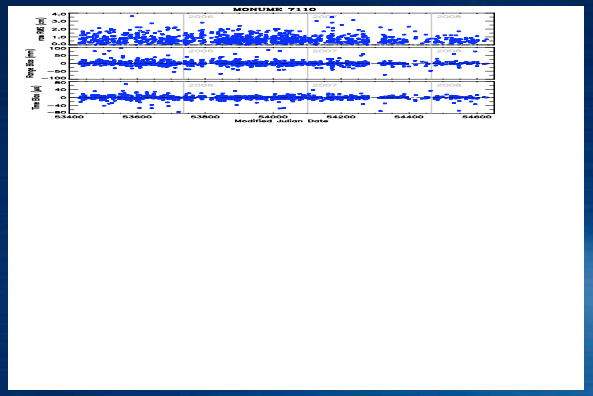


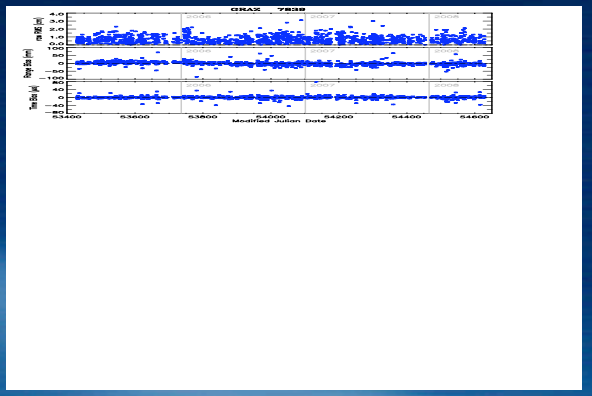


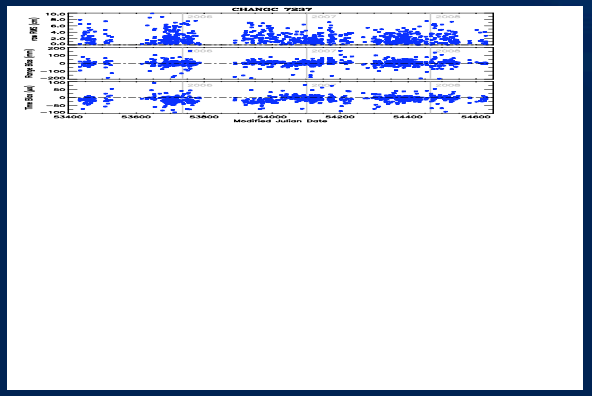
Short-arc POD

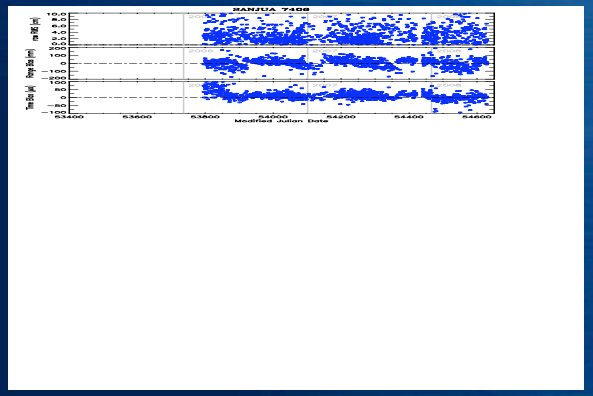
Station performance (LAGEOS-2)

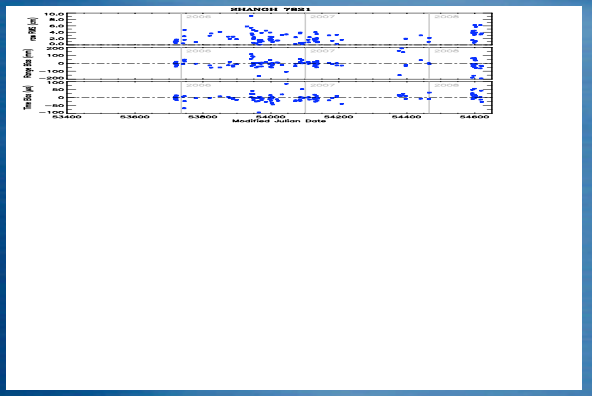












Short-arc POD

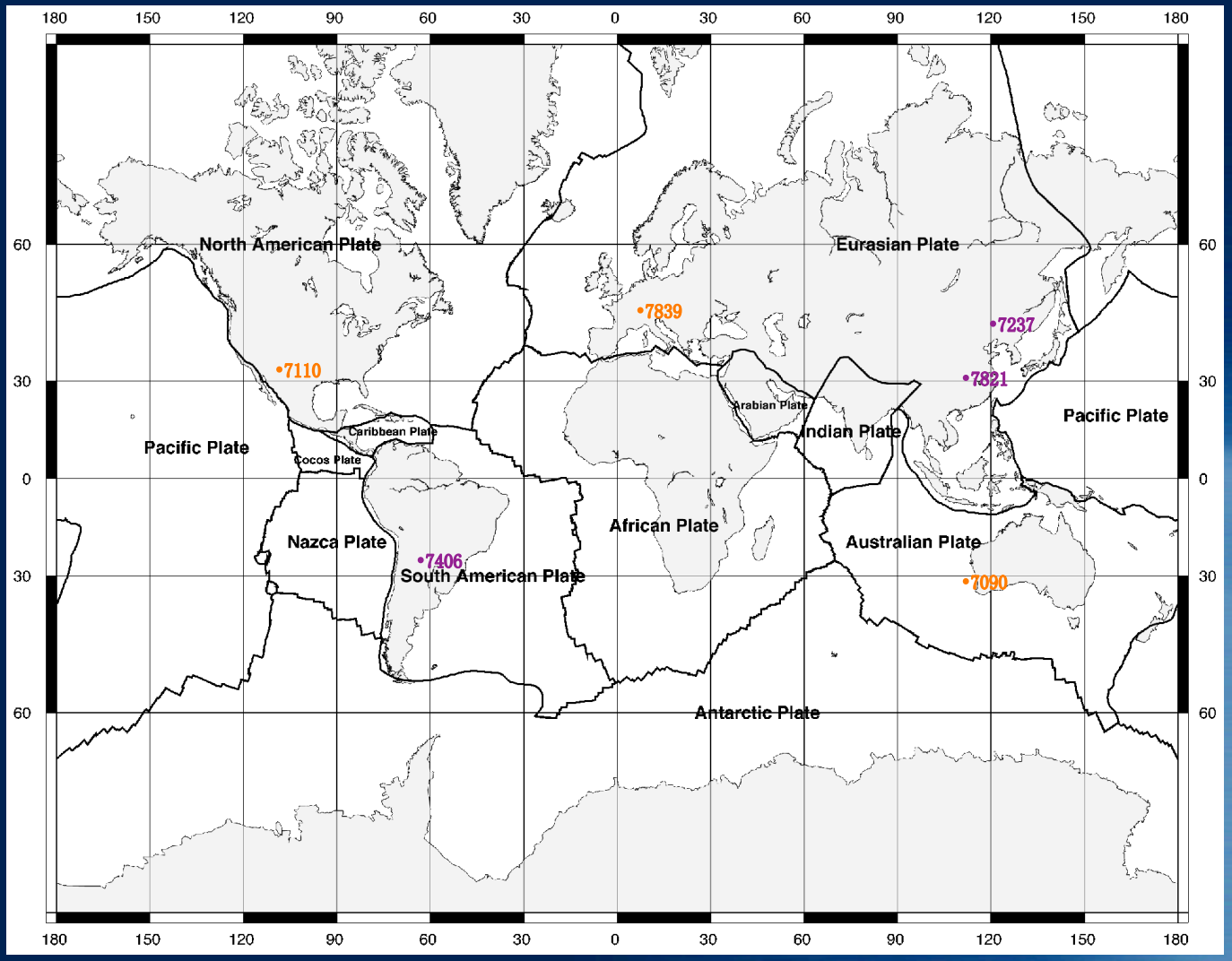
Station Statistics on LAGEOS-1

S_ID	Nobs	Mean RMS (cm)	Mean RB (mm)	Mean |RB| (mm)	Mean TB (us)	Mean |TB| (us)
7090	3250	0.7	1	7	1	4
7110	1257	0.8	-2	10	0	6
7839	1505	0.7	-3	8	0	3
7237	996	2.2	8	25	1	11
7406	1480	2.9	14	32	-10	18
7821	82	2.3	-9	30	6	12

Station Statistics on LAGEOS-2

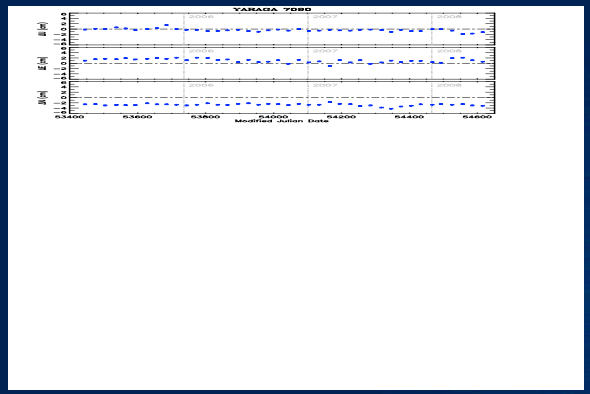
S_ID	Nobs	Mean RMS (cm)	Mean RB (mm)	Mean |RB| (mm)	Mean TB (us)	Mean |TB| (us)
7090	2819	0.7	2	8	-2	5
7110	948	0.7	0	9	-1	6
7839	1112	0.7	-2	8	0	4
7237	783	2.1	3	21	-10	16
7406	1101	3.0	6	33	12	18
7821	116	2.2	-6	26	-3	14

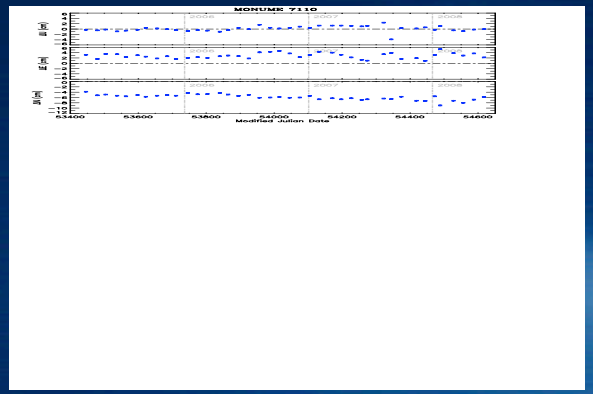
Assessment of station coordinates

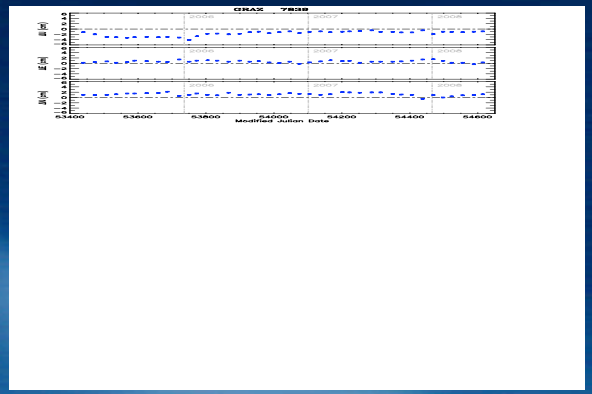


Assessment of station coordinates

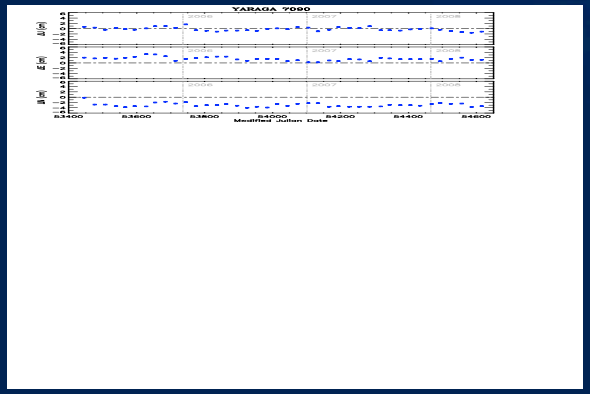
[From LAGEOS-1]

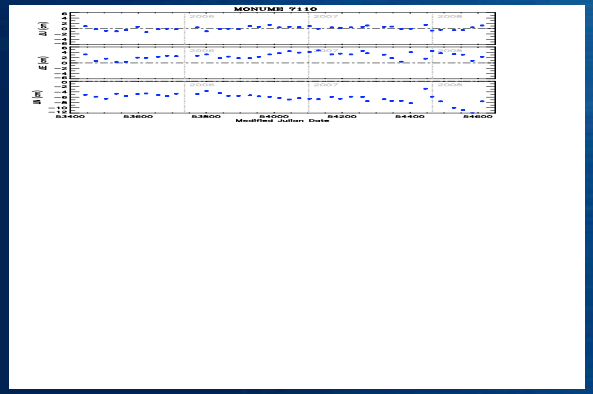


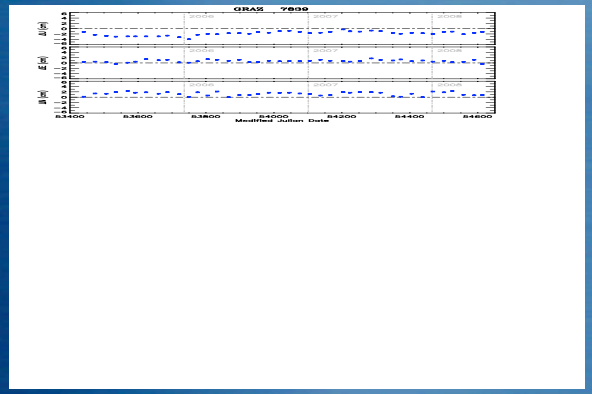




[From LAGEOS-2]

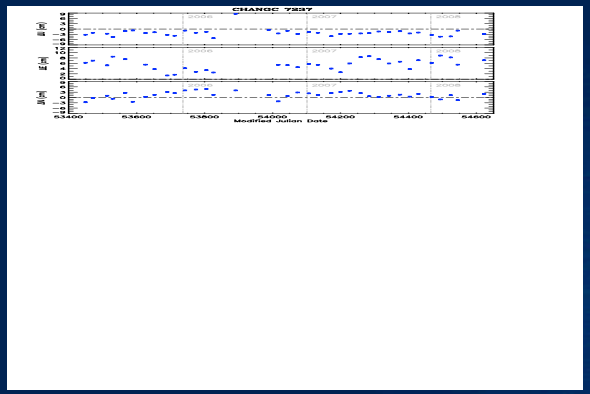


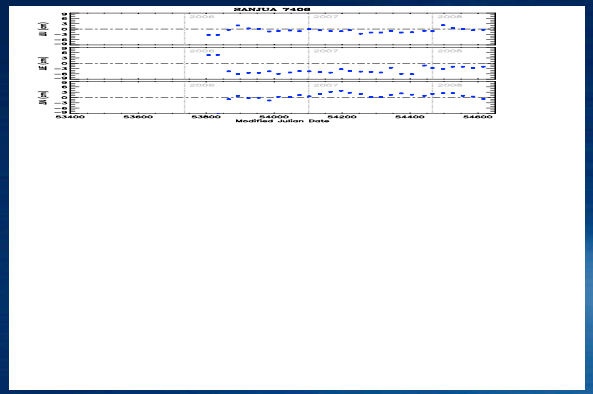


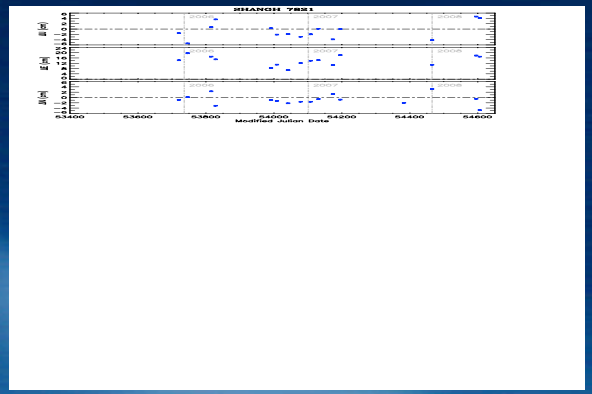


Assessment of station coordinates

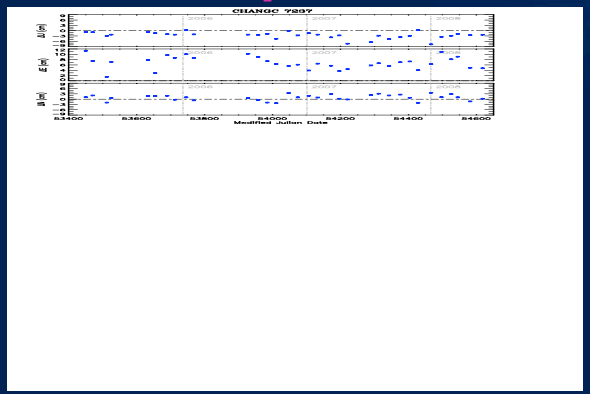
[From LAGEOS-1]

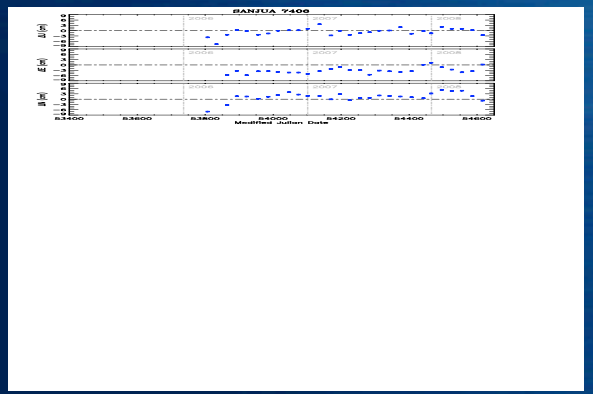


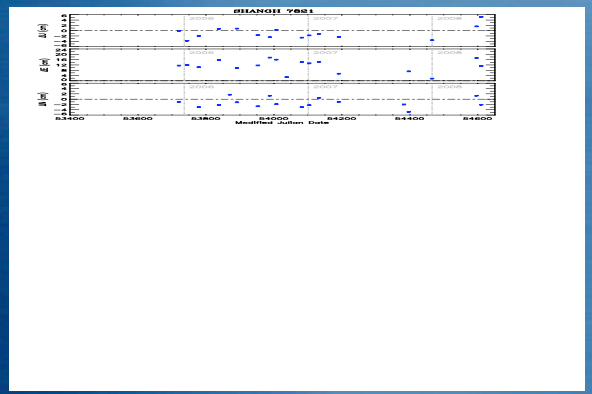




[From LAGEOS-2]







Assessment of station coordinates

YARAGA (7090)	**LAGEOS-1**	-2389006.926±0.007	5043329.319±0.006	-3078524.911±0.004
	LAGEOS-2	-2389006.930±0.007	5043329.318±0.007	-3078524.915±0.006
	Mean	**-2389006.928**	**5043329.319**	**-3078524.913**
	ITRF2000 (X Y Z)	**-2389006.924**	**5043329.339**	**-3078524.890**
	Δ (m)	***-0.004***	***-0.020***	***-0.023***
MONUME (7110)	**LAGEOS-1**	-2386278.201±0.008	-4802354.186±0.010	3444881.552±0.006
	LAGEOS-2	-2386278.202±0.009	-4802354.189±0.011	3444881.548±0.012
	Mean	**-2386278.202**	**-4802354.188**	**3444881.550**
	ITRF2000 (X Y Z)	**-2386278.211**	**-4802354.145**	**3444881.598**
	Δ (m)	***0.009***	***-0.043***	***-0.048***
GRAZ (7839)	**LAGEOS-1**	4194426.495±0.007	1162694.033±0.004	4647246.646±0.007
	LAGEOS-2	4194426.494±0.006	1162694.034±0.005	4647246.646±0.008
	Mean	**4194426.495**	**1162694.034**	**4647246.646**
	ITRF2000 (X Y Z)	**4194426.517**	**1162694.033**	**4647246.650**
	Δ (m)	***-0.022***	***0.001***	***-0.004***

Assessment of station coordinates

CHANGC (7237)	LAGEOS-1	-2674386.763±0.023	3757189.253±0.011	4391508.396±0.013
	LAGEOS-2	-2674386.782±0.024	3757189.242±0.014	4391508.395±0.028
	Mean	**-2674386.773**	**3757189.248**	**4391508.396**
	ITRF2000 (X Y Z)	**-2674386.739**	**3757189.307**	**4391508.401**
	Δ (m)	***-0.034***	***-0.059***	***-0.005***
SANJUA (7406)	LAGEOS-1	1984104.345±0.014	-5068867.136±0.011	-3314482.617±0.012
	LAGEOS-2	1984104.335±0.061	-5068867.131±0.025	-3314482.618±0.026
	Mean	**1984104.340**	**-5068867.134**	**-3314482.618**
	Epoch2008.5 (X Y Z)	**1984104.385**	**-5068867.122**	**-3314482.627**
	Δ (m)	***-0.045***	***-0.012***	***0.009***
SHANGH (7821)	LAGEOS-1	-2830744.265±0.112	4676580.307±0.080	3275072.892±0.107
	LAGEOS-2	-2830744.272±0.066	4676580.299±0.034	3275072.910±0.035
	Mean	**-2830744.269**	**4676580.303**	**3275072.901**
	Epoch2008.5 (X Y Z)	**-2830744.161**	**4676580.368**	**3275072.922**
	Δ (m)	***-0.108***	***-0.065***	***-0.021***

Summary

- For LAGEOS, the present ability of our precise orbit determination work is in the middle level about 1 to 2 cm;
- In the case of our study, the choice of gravity model has slight effect on precision of LAGEOS orbit determination. The influencing order in on sub-mm level.
- It can also been seen that for LAGEOS, although the observation quantity of Changchun is ranked round about 10th, the observation quality is only in moderate level, and has obvious gap with high-performance station.
- The station coordinates can be determinated in POD process, and the proper value can do help to improve orbit determination precision.
- The cause of variability of station coordinates need to be further investigated.
- We wish the POD work in Changchun will build a bridge which can connect theoretical research and observational work.


•THANK YOU