

VLBI Research Activities for Astrometry and Geodesy at Shanghai Astronomical Observatory

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Abstract

This report summarizes the current status, research activities and plans of the astrometric and geodetic VLBI group of Shanghai Astronomical Observatory for VLBI and IVS.

1. Introduction

Under the umbrella of Chinese national reforming and opening policy, the Creative Project of Chinese Academy of Sciences, which will be carried over to the next century, was started last year. Personnel and research activities of the astrometric and geodetic VLBI group of Shanghai Astronomical Observatory (SHAO), also as one of the 27 research groups of the National Astronomical Observatory, were reorganized to fit with this project. In this report we will address to colleagues our current status, research activities and plans for future work in order to promote basic understandings and cooperations.

2. Current Status and Research Activities

2.1. The Astrometric and Geodetic VLBI Group, SHAO

The Astrometric and Geodetic VLBI Group at SHAO was established in the middle of the 1980s. At that time, the VLBI group belonged to the Radio Astronomy Division, SHAO. The research divisions were reformed and the Center for Astro-geodynamics Research was established at SHAO in 1995. Since then, the Astrometric and Geodetic VLBI Group belongs to this center. Recently, the VLBI Group and the fundamental astrometry group were combined as one group, and is one of the research groups of the National Astronomical Observatory.

The members of the VLBI Group are as follows:

Li, Jinling	<i>Research Professor, head of the VLBI Group</i>
Qian, Zhihan	<i>Research Professor</i>
Jin, Wenjing	<i>Research Professor</i>
Yan, Haojian	<i>Research Professor</i>
Wang, Guangli	<i>Research Assistant</i>
Wang, Shuhe	<i>Associate Research</i>
Zhou, Ruixian	<i>Senior Engineer</i>
Tang, Zhenghong	<i>Research Assistant</i>

The NASA/GSFC's Geodetic VLBI software, CALC8.2/SOLVE/GLOBL which has been installed on a HP C-180 workstation is used for VLBI data analysis.

2.2. Global Solution for Astrometric and Geodetic VLBI Experiments

Shanghai Astronomical Observatory is one of the VLBI data analysis centers of the International Earth Rotation Service (IERS) and the International VLBI Service (IVS). We have submitted our analysis results to IERS annually. This year, our analysis covers the celestial and terrestrial reference frames (CRF and TRF) and Earth Orientation Parameters (EOP), and is based on all the historical astrometric and geodetic VLBI observations available to us up to January of 1999. It is the first time for us to perform a global solution with the data spanning more than 20 years.

Comparisons of our solutions with ITRF (96), ICRF (RSC (WGRF) 95 R01) and EOP (IERS) C04 are performed. For CRF, the three orientation angles are not significant at the level of precision of $0.02mas$. However, though no significant values are found for the three deformation parameters, local deformations up to $0.5mas$ are still identifiable. Details are still under investigation. For TRF, the orientation angles and their rates of change are not significant respectively at the precision level of $0.1mas$ and $0.05mas/yr$. Detailed comparisons with ITRF96 show that our solution gives higher motions for the eastern part of the Eurasian plate in the southeast direction and for Australian plate in the south direction by several millimeters per year. About EOP series, the systematic differences and the relative drifts are also not significant respectively at the precision level of $0.1mas$ and $0.05mas/yr$. These show that our solutions this year are pretty good.

2.3. Asia-Pacific Space Geodynamics Project

The Asian-Pacific Space Geodynamics (APSG) project was sponsored and organized by Prof. Shuhua Ye, Academician of the Chinese Academy of Sciences (CAS) in 1996, and is an international cooperation program being carried over to the next century. The primary objectives for the APSG project are to measure and monitor the current crustal movement and deformation in the Asian-Pacific region using high precision space geodetic techniques such as VLBI, GPS and SLR, and so to investigate various crustal motion rooted natural hazards, such as earthquakes, volcanic eruptions, etc. The project is expected to contribute to the means for mitigating and preventing natural disasters as well.

In October of 1997, the astrometric and geodetic VLBI group of SHAO, cooperating with GSFC VLBI group, NASA, USA, organized the VLBI experiments of the first APSG campaign. The second APSG VLBI campaign was carried out in November of 1998. We presently intend to organize one campaign per year in the following years. Each campaign consists of two 24-hour sessions.

From data analysis of the 1997 and 1998 APSG VLBI campaigns, the followings are illustrated:

- The mean accuracy of the baseline length measurements for the VLBI stations in the Asian-Pacific region is about 1.3×10^{-9} , which is consistent with the repeatability of baseline length measurement for other VLBI stations in the world.
- Regarding the VLBI measurements of the station velocities, they are in good consistence with the predictions of NUVEL1A-NNR for stations such as Gilcreek, Alaska (USA) and Hobart, Tasmania (Australia). However, they are not well consistent for stations such as Sheshan and Urumqi (China), Kashima (Japan) and Kokee, Hawaii (USA). Therefore, the plate motion model well describes the large-scale behaviors of global tectonic plates, rather than contemporary deformations taking place within plates or along boundary region.
- The detected eastward motion of Sheshan station and the north by northeast motion of

Urumqi station are of important significance to the study of the modern crustal movement of China, which directly indicates the effect of the northward movement of the Indo plate on the rising Tibetan Plateau and on the motion of the Tian Shan mountain area in the northwest part of China as well as on that of the eastern part of China.

- The westward motion of the Kashima station of Japan is closely related with the westward motion of the Pacific plate.

2.4. Chinese National Research Projects

Our activities are also involved in several Chinese national research projects, such as:

- Contemporary Crustal Motion and Geodynamics;
- Crustal Movement Observation Network of China;
- Mechanism and Prediction of Chinese Continental Intensive Earthquakes.

Outstanding characteristics such as high precision repeatability for long baseline length measurements and providing high precision observations in the quasi inertial deep space background, make VLBI one of the key supporting techniques of these projects. We mainly undertake the coordination of VLBI experiments, data processing, archive and reduction. Also, we provide the data analysis results of the change rates of baseline components and current motions of VLBI sites in China for further investigations.

2.5. Application Studies and Modeling of Data of VLBI

We are also devoted to application studies of VLBI to the establishment and maintenance of celestial and terrestrial reference frames (CRF and TRF), and the determination of Earth orientation parameters (EOP) and their interpretation.

On the CRF, we are interested in factors related to maintenance and stability, such as the method for the selection of defining sources, improvement of position precision of other sources, identification of local deformations, source structure and its variation, the rotational Galaxy and so on. We are also devoted to the improvement of the proper motion precision of Hipparcos stars using historical plates archived in Sheshan Section of Shanghai Astronomical Observatory, to precise position determination of optical counterparts of radio sources with CCD, and so to the tie between the optical and radio frames.

On the TRF, we are interested in the determination of local motion of stations relative to the prediction of plate models. Then, regional local motion can be statistically identified. These are important inputs for geodynamic studies of current crustal movement. Because of the high repeatability for the measurement of long baseline length, VLBI station is qualified as high precision reference point for regional geodesy.

On modeling the data, we are devoted to the improvements for corrections of the atmosphere effect.

3. Plans for VLBI and IVS

VLBI will continue to plan an important role in the establishment and maintenance of celestial reference frame, the determination of Earth orientation parameter and in global and regional

studies of crustal motions. We will be devoted much to global and regional VLBI data reduction, applications and modeling data.

4. Recent publications

- Jinling Li, Wenjing Jin. A new approach to the compilation of combined extragalactic radio source catalogues. *Astronomical and Astrophysical Transactions*, 1998, Vol.16, 31-35.
- Jinling Li, Guangli Wang. Corrections to the IAU 1976 precession constant and the coefficients of the IAU 1980 nutation series from VLBI observations. *Chinese Science Bulletin*, 1998, Vol.43 No.12, 1019-1023
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- Jinling Li. An introduction of the SVD algorithm and its test of artificial data. *Annals of Shanghai Astronomical Observatory*, 1998 (19), 16-21
- Jinling Li, Dawei Zheng. The temporal variations of the free core nutation, *Acta Astronomical Sinica*, 1998, Vol.39, No.3, 308-312
- Jinling Li, Dawei Zheng. Possible temporal variations of the free core nutation and forced nutations. In: *Geodesy on the Move, Gravity, Geoid, Geodynamics and Antarctica*. IAG Symp.119, 1998. IAG Scientific Assembly, Rio de Janeiro, September 3-9, 1997, pp326-331
- Jinling Li, Zhihan Qian, Guangli Wang. The motion of the Shanghai collocation site relative to the Eurasia plate. In: *Proceedings of the international workshop on geodetic measurements by the collocation of space techniques on earth*. January 25-28, 1999, at the Communications Research Laboratory, Koganei, Tokyo, Japan. pp184-188