

# Analysis Center at Communications Research Laboratory

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## Abstract

This report summarizes the activities of the Analysis Center at the Communications Research Laboratory (CRL) to the end of 2001. The operational KSP observations were finished at the end of November, 2001. Thus, the Analysis Center at the CRL has concentrated mainly on experimental campaigns for developing new techniques.

## 1. Introduction

One of the main objectives of the Analysis Center at the Communications Research Laboratory (CRL) was to monitor regional deformation and strain accumulation at the plate boundary region of the Kanto district using the Key Stone Project (KSP) network. The KSP operational observations were finished at the end of November, 2001. VLBI analyses at CRL are being mainly concentrated on experimental campaigns for developing new techniques such as Gbps VLBI system and the Internet VLBI system at present. We are conducting analysis activities with VLBI, GPS and water vapor radiometer (WVR) in order to improve the atmospheric model and to evaluate the accuracy of the space geodetic techniques.

## 2. Analysis Activities

### 2.1. Crustal deformation detected by the KSP network

Figure 1 plots the estimated lengths of the baseline between Kashima and Tateyama stations measured by using VLBI. Two characteristics are remarkable in these data. One is the linear trend of the shortening of the baseline and the other is an episodic event due to the volcano seismic activities in the Izu Islands during June - August 2000. Therefore, we describe the KSP results for three periods: (A) pre-event (before June 25, 2000), (B) during the event (June 26 - September 30, 2000), and (C) post-event (after October 1, 2000). Observed horizontal station velocities (millimeters per year) during period (A) and period (C) and accumulated north-east displacements at KSP stations during period (B) are presented in this figure. The rates of the baseline length changes between the four stations of the KSP network during the first period (A) are summarized in Table 1. The results of the GPS measurements are also given.

As of mid-September 2000, according to the results from continuous GPS measurements of GSI's GEONET at the islands, the crustal deformation around Izu Islands had almost decayed. We summarize the rates of the baseline length changes between three KSP stations during the third period in Table 2. The rates of the baseline changes during period (C) are almost consistent with the previous rates which were detected during period (A).

### 2.2. Quasi-realtime estimation of Earth's Rotation Pole Positions and UT1-UTC

The real-time KSP VLBI system and the automated data analysis system play important roles in performing quasi-realtime observations. These systems also enable us to estimate Earth's orientation parameters (EOP) in quasi-realtime. Based on our analysis results we find EOP estimation

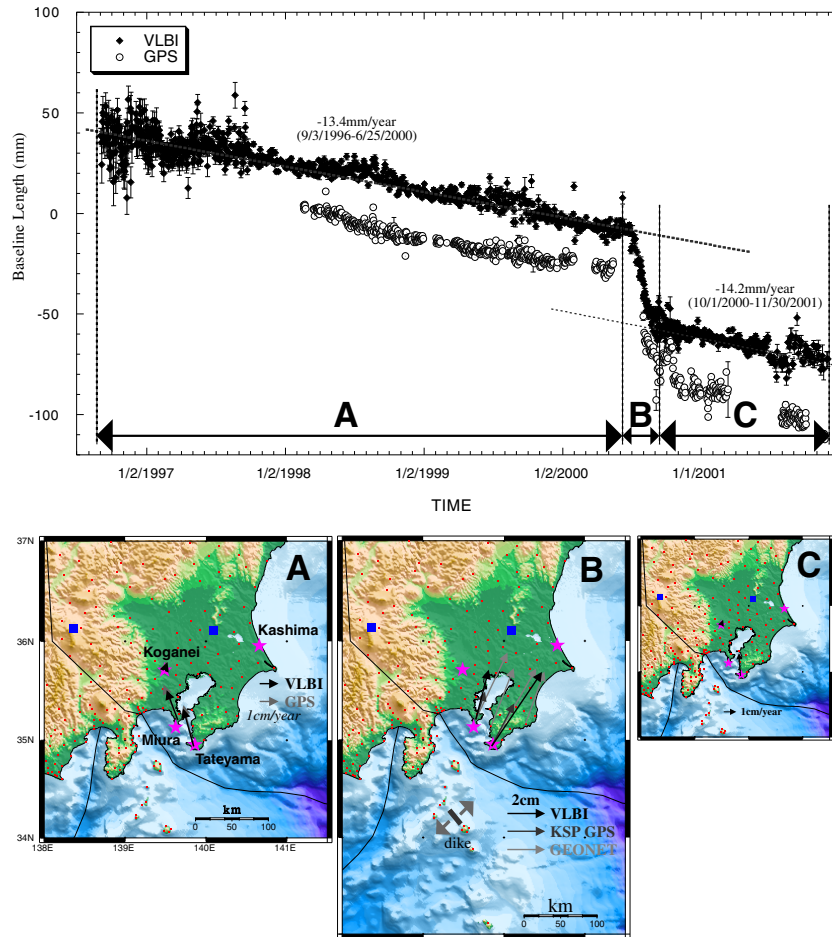


Figure 1. Upper: Estimated baseline length between Kashima and Tateyama measured using VLBI (upper). Lower: Observed horizontal site velocities (centimeter per year) relative to Kashima site during periods (A) and (C), and accumulated displacements (centimeter) observed from VLBI, KSP GPS and GEONET GPS sites during period (B).

Table 1. Baseline length changes between the four KSP stations from January 1, 1998 to June 25, 2000.

Baseline	VLBI (mm/yr)	GPS (mm/yr)
Kashima-Koganei	-2.6	-3.3
Kashima-Miura	-6.6	-8.0
Kashima-Tateyama	-13.8	-15.8
Koganei-Miura	-13.2	-13.0
Koganei-Tateyama	-17.3	-23.1
Miura-Tateyama	-3.6	-8.8

method to be significantly useful for improving the accuracy of EOP prediction. The formal error of the estimated UT1-UTC from the KSP VLBI data was better than the predictions at five days

Table 2. Baseline length changes between the three KSP stations from October 1, 2000 to May 31, 2001.

Baseline	VLBI (mm/yr)	GPS (mm/yr)
Kashima-Tateyama	-12.6	-21.4
Koganei-Tateyama	-17.9	-20.2

afterwards in Bulletin A[1]. This estimation suggests that the KSP VLBI data can improve on currently available UT1-UTC estimation. The estimation accuracies can be improved by simply expanding the baseline lengths of the network.

### 2.3. Evaluation of tropospheric path delay

The repeatability of the baseline length obtained by KSP VLBI measurements tends to be degraded in summer. We investigate position change of the Kashima station caused by the horizontal variability of the water vapor by means of simulation analysis using ray-tracing techniques[2]. In addition, observations using water vapor radiometers (WVRs) at the KSP Kashima station and at Tsukuba are also carried out for detecting and characterizing water vapor variations[3].

### 2.4. Other topics

- Ionospheric delay correction with GPS-based Earth ionosphere total electron content (TEC) measurement is being evaluated for the purpose of finding single band VLBI application, for example, pulsar astrometry and geodetic VLBI with a single band receiver[4].
- Compact and strong radio sources were repeatedly observed using the KSP VLBI system. By analysis of five years of observed data irregular variations in the flux densities were detected for several radio sources[5].

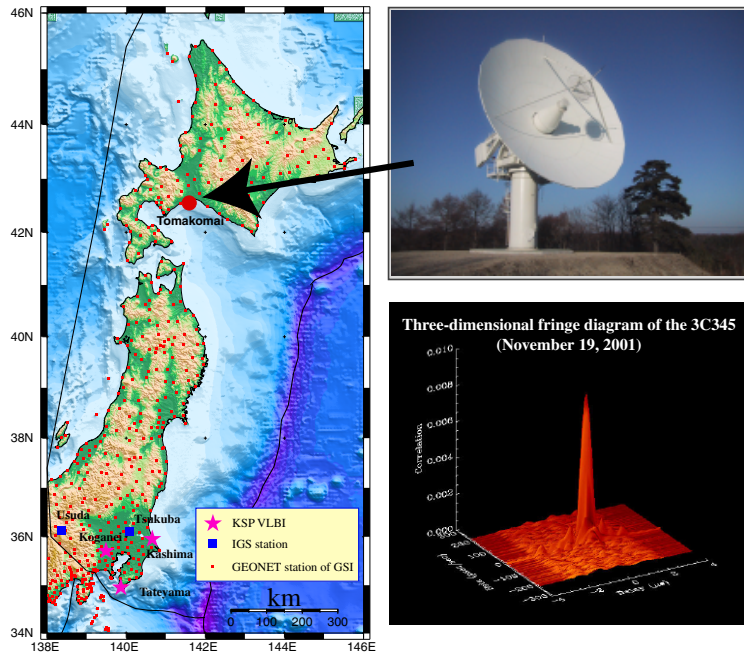


Figure 2. Location of Tomakomai 11-m antenna. The first fringe diagram of 3C345 is also shown.

- Three GPS stations, two at Koganei(KGNI and KGN0) and one at Kashima(KSMV), were registered on the IGS network. Each antenna monument at KGNI and KSMV is close to each KSP 11-m VLBI antenna. The data sets of these stations have been available at CDDIS

since last October, 2001.

- The VLBI system that was used at the Miura station until the end of 2000 was moved to Hokkaido University's new station Tomakomai. The first geodetic VLBI experiment with the Tomakomai, KSP Kashima, and Kashima's 34-m antennas was successfully performed in November, 2001. The location of Tomakomai and the first fringe diagram of 3C345 are shown in Figure 2.

### 3. Staff

The staff members who are contributing to the KSP Analysis Center at the CRL are listed below:

- Kondo Tetsuro, Responsible for overall operations and performance.
- Koyama Yasuhiro, Development of data analysis software.
- Ichikawa Ryuichi, Research on crustal deformation and atmospheric modeling.
- Amagai Jun, Maintenance of the data analysis system.

### 4. Outlook

During the year 2002 the plans of the Analysis Center at CRL include:

- Several experiments using Kashima and Koganei 11-m antennas for developing the Internet VLBI and the Gbps VLBI systems.
- Domestic experiments for the ITRF collocation with GSI and/or Hokkaido University.
- Comparisons of the tropospheric parameters derived from VLBI, GPS, WVR and non-hydrostatic numerical weather prediction data.

KSP data sets is provided at th URL <http://ksp.crl.go.jp/index.html>. Though the KSP project was finished last year, the KSP web site continues to hold all the data obtained by the KSP VLBI network. General Information of VLBI activities at the CRL is provided at <http://www2.crl.go.jp/ka/radioastro/index.html>.

### References

- [1] Koyama Y., Estimation of UT1-UTC and Earth's Rotation Pole Positions from the KSP Network VLBI Data, IERS TDC News, 13, pp. 6-8, 1998.
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- [4] Sekido M., Kondo T., Eiji K., and Imae M., Comparison of ionospheric delay obtained by GPS and VLBI, submitted to Radio Sci., 2000.
- [5] Koyama Y., Microwave flux density variations of compact radio sources monitored by real-time very long baseline interferometry, Radio. Sci., 36, pp. 223-235, 2001.