

The BKG/IGGB VLBI Analysis Center

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Abstract

In 2009, the activities of the BKG/IGGB VLBI Analysis Center, as in previous years, consisted of routine computations of Earth orientation parameter (EOP) time series and of a number of research topics in geodetic VLBI. The VLBI group at BKG continued its regular submissions of time series of tropospheric parameters and the generation of daily SINEX (Solution INdependent EXchange format) files. Quarterly updated solutions have been computed to produce terrestrial reference frame (TRF) and celestial reference frame (CRF) realizations. Routine computations of the UT1–UTC Intensive observations include all sessions of the Kokee–Wettzell and Tsukuba–Wettzell baselines and the networks Kokee–Svetloe–Wettzell and Ny-Ålesund–Tsukuba–Wettzell. The data analysis was refined and the work for the IERSU Working Group on ICRF2 was completed. At IGGB, the emphasis has been placed on individual research topics.

1. General Information

The BKG/IGGB VLBI Analysis Center has been established jointly by the Federal Agency for Cartography and Geodesy (BKG), Leipzig, and the Institute of Geodesy and Geoinformation of the University of Bonn (IGGB). Both institutions maintain their own analysis groups in Leipzig and Bonn but cooperate intensely in the field of geodetic VLBI. The responsibilities include data analysis for generating IVS products as well as special investigations with the goal of increasing accuracy and reliability. BKG is responsible for the computation of time series of EOP and tropospheric parameters, for the generation of SINEX files for 24-hour VLBI sessions and 1-hour Intensive sessions, and for the generation of quarterly updated global solutions for TRF and CRF realizations. Besides data analysis, the BKG group is also responsible for the scheduling of the Tsukuba–Wettzell INT2 UT1–UTC observing sessions. IGGB continues to host the office of the IVS Analysis Coordinator and carries out special investigations within the techniques of geodetic and astrometric VLBI. Details of the research topics of BKG and IGGB are listed in Section 2.

2. Data Analysis

At BKG, the Mark 5 VLBI data analysis software system Calc/Solve, release of December 05, 2008 [4], has been used for VLBI data processing. It is running under Fortran 90 on a PC with the GNU/Linux 2.6.5-7.97-smp operating system. The software includes the new Calc 10 implementation for complying with the IAU 2000 Resolutions and the IERS Conventions 2003. The Vienna Mapping Function (VMF1) implemented in a Solve version modified in Leipzig for this purpose was used for all data analyses. There were no negative effects in the daily update of the VMF1 data from the server of the Technical University of Vienna. In addition, an independent technological software environment for the Calc/Solve software is available. The latter is used for linking up the Data Center management with the pre- and post-interactive parts of the EOP series production and for monitoring all Analysis and Data Center activities.

- **Processing of correlator output**

The BKG group continued the generation of calibrated databases for the sessions correlated

at the MPIfR/BKG Mark 5 Astro/Geo Correlator at Bonn (e.g., EURO, OHIG, and T2) and submitted them to the IVS Data Centers.

- **Scheduling**

BKG continued scheduling the INT2 Intensive sessions, which are observed on the baseline TSUKUBA-WETTZELL. Altogether 104 schedule files were created in 2009.

- **BKG EOP time series**

A new EOP time series bkg00012 was created. The data analysis was done with the thermal expansion modelling published in [6]. Instead of the high frequency EOP model hf1102a, the short period ocean tide and nutation contributions to EOP in accordance with the IERS Conventions 2003 were used. For modelling of ocean tide loading, the model FES2004 [5], as made available from H. G. Scherneck [7], was applied. Furthermore, the new a priori set of coordinates and velocities, VTRF2008a, generated as input to ITRF2008 [3] was used in data processing.

Each time after the preprocessing of any new VLBI session (correlator output database version 1), a new global solution with 24-hour sessions since 1984 has been computed, and the EOP time series bkg00012 has been extracted. Altogether 3953 sessions have been processed. The main parameter types in this solution are globally estimated station coordinates and velocities together with radio source positions. The datum definition was realized by applying no-net-rotation and no-net-translation conditions for 26 selected station positions and velocities with respect to VTRF2008a and a no-net-rotation condition for 212 defining sources with respect to ICRF/ICRF-Ext.1. The station coordinates of the telescopes AIRA (Japan), BADARY (Russia), CHICHI10 (Japan), CTVAJSTJ (Canada), DSS13 (USA), PT_REYES (USA), SEST (Chile), SINTOTU3 (Japan), WIDE85_3 (USA), and YEBES40M (Spain) were estimated as local parameters in each session.

The UT1-UTC Intensive time series bkgint07 was replaced by bkgint08 with the new models mentioned above. In addition to the observations of the two baselines KOKEE-WETTZELL and TSUKUBA-WETTZELL, also the networks KOKEE-SVETLOE-WETTZELL and NYALES20-TSUKUBA-WETTZELL, each with a duration of about 1 to 1.5 hours, were processed regularly. The series bkgint08 was generated with fixed TRF (VTRF2008a) and fixed CRF derived from the global BKG solution for EOP determination. The estimated parameter types were only UT1-TAI, station clock, and zenith troposphere. A total of 3112 UT1 Intensive sessions were analyzed for the period between 1999.01.01 and 2009.12.31.

- **Quarterly updated solutions for submission to IVS**

In 2009, one quarterly updated solution was computed for the IVS products TRF and CRF. There are no differences in the solution strategy compared to the continuously computed EOP time series bkg00012. The results of the radio source positions were submitted to IVS in IERS format. The TRF solution is available in SINEX format, version 2.1, and includes station coordinates, velocities, and radio source coordinates together with the covariance matrix, information about constraints, and the decomposed normal matrix and vector. In the frame of the ICRF2 working group, a solution for the ICRF2 catalog and the corresponding TRF was also created with special requirements for the CRF.

- **Tropospheric parameters**

The VLBI group of BKG continued regular submissions of long time series of tropospheric

parameters to the IVS (wet and total zenith delays, and horizontal gradients) for all VLBI sessions since 1984. The tropospheric parameters were extracted from the standard global solution bkg00012 and transformed into SINEX format.

- **Daily SINEX files**

The VLBI group of BKG also continued regular submissions of daily SINEX files for all available 24-hour sessions for the IVS combined products [2] and for the IVS time series of baseline lengths. In addition to the global solutions, independent session solutions with the new models mentioned above were computed for the station coordinates, EOP parameters, and nutation parameters. The a priori datum for TRF is defined by the VTRF2008a, and the fixed CRF derived from the complete global BKG solution for EOP determination is used for the a priori CRF information.

- **SINEX files for Intensive sessions**

The parameter types are station coordinates, pole coordinates and their rates, and UT1-TAI and its rate. But only the normal equations stored in the SINEX files are important for further combination with other space geodetic techniques.

3. Research Topics

- **Further work for ICRF2**

The special investigations at BKG concerning long-term stability of radio sources in VLBI analysis on the basis of time series of radio source positions in the frame of the ICRF2 working group were completed [8]. 226 stable radio sources with an axis stability of 0.01 mas could be identified. They include 100 ICRF2 axis-defining sources determined independently from the method applied in the ICRF2 working group. It was found that 29 radio sources with a source structure index of less than 3.0 are stable enough that they could be used to increase the number of 295 ICRF2 defining sources.

- **CONT08 Pre-release tests**

Prior to the release of the correlator output of the CONT08 sessions, a preliminary quality check was performed at Bonn in order to avoid inconsistencies in the data. For this, preliminary solutions were calculated for the 15 individual sessions, and the site coordinate repeatabilities were checked. The data proved to be according to the specifications, and the databases were released five days later.

- **Input to ITRF2008**

IGGB has computed its own solution for IVS' input to ITRF2008. For 4370 sessions with 112 sites from 1979.7 to 2009.0, datum-free normal equations have been generated from analyses with the Calc/Solve software installed at Bonn [3].

- **Sub-daily EOP determinations**

At Bonn, investigations of sub-daily EOP variations in CONT02, CONT05, and CONT08 data have been carried out and the CONT08 results have been published [1]. It turned out that the drop-out of Gilcreek and Algonquin Park weakened the network for sub-daily EOP determinations, and the results are slightly noisier than those of CONT05. Although scheduled for an atmospherically more active period in August (compared to September 2005 and October 2002), no stronger atmospherically induced signals were found in the CONT08

data. Amplitudes at non-tidal periods, e.g., at 6 h and 8 h, could be detected with different characteristics for the three campaigns.

In addition, investigations into the estimation of an empirical sub-daily EOP model have been performed. Here, three different approaches for the computation of a sub-daily EOP model have been tested and compared: (a) the estimation based on EOP time series, (b) based on normal equation systems and (c) based on the observation equation systems. Moreover, the stability and reliability of the estimated coefficients have been assessed by comparing the coefficients estimated from data of different time spans.

4. Personnel

Table 1. Personnel at BKG/IGGB Analysis Center

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