The BKG/IGGB VLBI Analysis Center

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Abstract

In 2011, 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. After a big earthquake on March 11th, 2011 near the Tsukuba station, no IVS products including Tsukuba Intensive observations could be delivered. 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 analysis groups of the Federal Agency for Cartography and Geodesy (BKG), Leipzig, and the Institute of Geodesy and Geoinformation of the University of Bonn (IGGB). Both institutions cooperate intensely in the field of geodetic VLBI. The responsibilities include both data analysis for generating IVS products and 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 writing schedules for the Tsukuba-Wettzell INT2 UT1-UTC observing sessions. In addition to this, schedules for observing the Kokee-Wettzell baseline on weekends were made after the Japan earthquake in March 2011. IGGB continues to host the office of the IVS Analysis Coordinator and carries out special investigations within the technique of geodetic and astrometric VLBI. Details of the research topics of IGGB are listed in Section 3.

2. Data Analysis at BKG

At BKG, the Mark 5 VLBI data analysis software system Calc/Solve, release 2010.05.21 [3], has been used for VLBI data processing. It is running on a Linux operating system. As in the previous releases, the Vienna Mapping Function (VMF1) has been implemented in a separate Solve version. This modified version was used for all data analysis. The VMF1 data were downloaded daily from the server of the Vienna University of Technology. Additionally, the technological software environment for Calc/Solve has been refined to link the Data Center management with the pre- and post-interactive parts of the EOP series production and to monitor 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 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 TSUKUBA-WETTZELL baseline. Due to the earthquake in Japan on March 11th, 2011, scheduling at BKG was extended for the INT1 Intensive sessions on the KOKEE-WETTZELL baseline on weekends. Altogether 153 schedule files were created in 2011.

- **BKG EOP time series**
  The BKG EOP time series bkg00013 was continued. The main features of this solution were not changed. Nevertheless, slight changes in modeling of the TSUKUB32 station from globally estimated station coordinates to locally estimated coordinates in all respective sessions were made. Furthermore three new VLBI stations in the southern hemisphere could be included successfully 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 was computed, and the EOP time series bkg00013 was extracted including the coordinates of those stations for which components were estimated for each session. Altogether 4246 sessions were 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 295 defining sources with respect to ICRF2. The station coordinates of the telescopes AIRA (Japan), CHICHI10 (Japan), CTVASTJ (Canada), DSS13 (USA), HOBART12 (Australia), PT_REYES (USA), SEST (Chile), SINTOTU3 (Japan), TIGOCONC (Chile), TSUKUB32 (Japan), WIDE85_3 (USA), VERAISGK (Japan), VERAMZSW (Japan), and YEBES40M (Spain) were estimated as local parameters in each session. The three new VLBI stations KATH12M (Australia), WARK12M (New Zealand), and YARRA12M (Australia) were modeled in the same way.

  Regular analysis of the UT1-UTC Intensive time series bkgint09 was continued. Reporting was extended to also list the a priori UT1-UTC values as well as the stations participating in each session. The series bkgint09 was generated with fixed TRF (VTRF2008a) and fixed ICRF2. The a priori EOP were taken from finals USNO series [7]. The estimated parameter types were only UT1-TAI, station clock, and zenith troposphere. Observations of the two baselines KOKEE-WETTZELL and TSUKUBA-WETTZELL and also of the networks KOKEE-SVETLOE-WETTZELL and NYALES20-TSUKUBA-WETTZELL were processed regularly. But no time series of Intensive sessions with station TSUKUBA were delivered to IVS after the Japan earthquake. The analysis of the INT3 sessions processed at the Bonn correlator every Monday after transferring the raw observations by e-transfer could be finished almost always on the same day. Maximal delays of one day appeared because of problems in data transfer. A total of 3803 UT1 Intensive sessions were analyzed for the period from 1999.01.01 to 2011.12.31.

- **Quarterly updated solutions for submission to IVS**
  In 2011, 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 bkg00013. 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, station velocities, and radio source coordinates together with the covariance matrix, information about constraints, and the decomposed normal matrix and vector.

- **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 bkg00013 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 and for the IVS time series of baseline lengths. In addition to the global solutions, independent session solutions were computed for the station coordinates, radio source coordinates, and EOP parameters including the X,Y-nutation parameters. The a priori datum for TRF is defined by the VTRF2008a, and ICRF2 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 intra-technique combination or combination with other space geodetic techniques.

3. Research Topics at IGGB

- **Determination of sub-daily tidal ERP models**
  To overcome deficiencies of the official IERS model for tidal Earth Rotation Parameter (ERP) variations with periods around one day and below [5], empirical models estimated from space geodetic techniques might be used. At IGGB, a method based on transformations of normal equation systems has been developed to estimate such a model [2]. This method has also been successfully applied to estimate combined sub-daily ERPs from GPS and VLBI observations [1]. Within this combination no constraints on the ERPs are necessary as geometric instabilities of the techniques are cross-wise compensated. The final combined model as published in [1] was distributed to the different services to be validated.
- **Automatic scheduling based on Singular Value Decomposition**
  An automatic scheduling process for VLBI Intensive sessions based on singular value decomposition has been developed [6]. Based on a simple starting configuration, the observations are selected successively by analyzing the Jacobian matrix. Indicators on the geometry of the measurement derived from the singular value decomposition are used for the selection of the sources to be observed with the purpose of improving the dUT1 determination. The formal errors of dUT1 deduced from the normal equation serve as an assessment criterion of the scheduling method. The new scheduling method shows promise for improvements of the dUT1 determination by IVS Intensive observing sessions.
- **Gravitational deformation of the Effelsberg radio telescope**
  Due to gravitation, the main reflector of a radio telescope undergoes a deformation, which

causes a change in focal length depending on the elevation angle of the telescope. In order to estimate these focal length variations of the 100-m radio telescope at Effelsberg, Germany, the main reflector was scanned at seven different elevation angles by a laser scanner mounted near the primary focus. A three-step adjustment procedure based on an alteration of the orthogonal distance regression and several outlier eliminations is then used to determine the variations of the elevation-dependent focal lengths [4]. The estimated focal length decreases by a maximum of 12.6 mm when tilting the reflector from 90° to 7.5° elevation angle. The post-fit discrepancies between the best-fit paraboloid and the reflector's surface are Gaussian distributed within the accuracy of the measurements, which supports the assumption of a homologous deformation of the main reflector.

4. Personnel

Table 1. Personnel at BKG/IGGB Analysis Center

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