The BKG/IGGB VLBI Analysis Center

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Abstract

In 2008 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 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 by using atmospheric pressure loading time series, and further work for the IVS Working Group on ICRF2 has been finished. 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 in the technique of geodetic and astrometric VLBI. Details of the research topics of BKG and IGGB are listed in Section 3.

2. Data Analysis

At BKG, the Mark 5 VLBI data analysis software system Calc/Solve, release of October 04, 2007, has been used for VLBI data processing. It is running under Fortran 90 on a machine with an operating system GNU/Linux 2.6.5-7.97-smp. It 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 part of the EOP series production and to monitor all Analysis and Data Center activities. (Data Center topics are described in the BKG Data Center report in this issue.)

- **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 101 schedule files were created in 2008.

- **IVS EOP time series**
  A new EOP time series bkg00011 was created. It differs from the previous one by using the atmospheric pressure loading time series provided by GSFC. Furthermore station coordinates and velocities for positions of DSS65A, METSAHOV, and ZELENCHK have been estimated in a global multi-session mode with about 3 years of data gathered up to now.

  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 bkg00011 has been extracted. Altogether 3,740 sessions have been processed. The main parameter types in this solution are globally estimated station coordinates and velocities together with radio source positions. Minimal constraints for the datum definition were applied to achieve no-net-rotation and no-net-translation for 26 selected station positions and velocities with respect to VTRF2005 and no-net-rotation for 212 defining sources with respect to ICRF-Ext.1. The station coordinates of the stations BADARY (Russia), CTVASTJ (Canada), DSS13 (USA), and YEBES40M (Spain) were estimated as local parameters in each session.

  The UT1-UTC time series bkgint07 was continued. In addition to the observations of both baselines KOKEE-WETTZELL and TSUKUBA-WETTZELL, also the networks KOKEE-SVETLOE-WETTZELL and NYALESUND-TSUKUBA-WETTZELL, each with a duration of about 1 to 1.5 hours, were processed regularly. Series bkgint07 was generated with fixed TRF (VTRF2005) 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 2,733 UT1 Intensive sessions were analyzed for the period between 1999.01.01 and 2008.12.31.

- **Quarterly updated solutions for submission to IVS**
  Also in 2008, quarterly updated solutions were computed for the IVS products TRF and CRF. There are no differences in the solution strategy compared to the continuously computed EOP time series bkg00011. 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.

- **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, horizontal gradients) for all VLBI sessions since 1984. The tropospheric parameters are directly extracted and transformed into SINEX for tropospheric estimates from the results of the standard global solution for the EOP time series bkg00011.

- **Daily SINEX files**
  The VLBI group of BKG also continued the regular submissions of daily SINEX files for all available 24-hour sessions as base solutions for the IVS time series of baseline lengths and for combination techniques. In addition to the global solutions, independent session solutions were computed for the parameter types station coordinates, EOP, and nutation parameters. The a priori datum for TRF is defined by the VTRF2005, and the fixed CRF derived from the global complete BKG solution for EOP determination is used for the a priori CRF information.

- **SINEX files for Intensive sessions**
  Due to special requirements from IVS, SINEX files for Intensive sessions were created. The parameter types are station coordinates, pole coordinates and their rates, and UT1-TAI with rate. But only the normal equations stored in the SINEX files are important for further combination with other space geodetic techniques.

3. Research Topics

- **Statistical tests for ICRF2**
  At BKG, the main work in 2008 has been the analysis of the time series of all radio sources computed in special CRF runs. Statistical tests to identify normal distribution of the residuals w.r.t. the weighted mean have been made for radio sources which had been observed in at least 20 sessions. The statistical hypothesis of normal distribution was not rejected for 227 radio sources in both components, declination and right ascension, and for 62 radio sources in only one component. After the successful test for normal distribution, an inspection of WRMS, of rate estimation, and of distribution of the data points (sessions) in time was also necessary to answer the question of whether sources can be considered as being stable.

- **Terrestrial reference frame for ICRF2**
  For the computations of solutions for ICRF2, it was agreed that all analysis centers participating in ICRF2 work use the same terrestrial reference frame (TRF). For this purpose, VTRF2008, which had been computed at Bonn at the same time, was selected. The details are described in the IVS Analysis Coordinator's report.

- **Sub-daily EOP determinations**
  At Bonn, the modelling of sub-daily EOP variations has been pursued further. For this, the Solve analysis software has been modified to permit the extraction of the design matrix for subsequent processing in a separate inversion program. The normal matrix of several VLBI sessions can be stacked to form a multi-session set of normal equations. Through this method, for example, the breaks in the CONT sessions can be bridged, reducing the noise in the sub-daily EOP at the session boundaries. Based on this modified analysis approach, several CONT campaigns have been re-analyzed and compared in the frequency domain.

- **Modifications of the local installation of Solve**
  The version of Solve installed at Bonn has been modified for a number of purposes. For combination studies with GPS, the logic of Solve was changed in order to produce EOP at full integer hours even for sessions which do not start at the full hour. For this and also other combination purposes, routines were added to extract the full design matrix and the system

of normal equations. These could then be processed with stand-alone inversion and analysis programs.

- **Systematic differences in EOP series**
  In 2006, the y-component of polar motion of all IVS Analysis Centers showed significant bumps in the time series when forming the differences w.r.t. the IGS results (Fig. 1). In 2008, this phenomenon was studied in detail, and possible causes were tested.
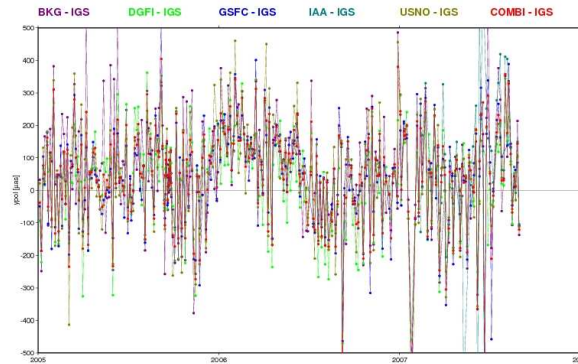

Figure 1. Differences w.r.t. IGS in y pole component
with systematic bumps in 2006

The conclusion of these investigations was that the appearance of the systematics was mainly driven by the results of the IVS-R4 sessions. This network was particularly affected by major changes in network constellations since GILCREEK (Dec. 31, 2005) and ALGOPARK (Aug. 5, 2006) dropped out of operation. Due to this, the R4 network appeared with an elongated shape from Hawaii and South America to Europe. The reduced sensitivity also became obvious through higher formal errors of the estimated EOP.

4. Personnel

Table 1. Personnel at BKG/IGGB Analysis Center

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