The BKG/GIUB VLBI Analysis Center

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Abstract

In 2006, the Geodetic Institute of the University of Bonn (GIUB) was renamed Institute for Geodesy and Geoinformation of the University of Bonn (IGGB). The activities at 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 were 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. At IGGB the emphasis was placed on individual research topics.

1. General Information

In 2006, the Geodetic Institute of the University of Bonn (GIUB) was renamed Institute for Geodesy and Geoinformation of the University of Bonn (IGGB). The jointly operated IVS Analysis Center of the Federal Agency for Cartography and Geodesy (BKG), Leipzig, and of the Institute for Geodesy and Geoinformation of the University of Bonn will, thus, continue to exist as BKG/IGGB VLBI Analysis Center. The relationship with IVS is not affected by this change of name.

Both institutions maintain their own analysis groups in Leipzig and Bonn but cooperate intensively 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, the generation of daily SINEX files, and 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 March 18, 2004 (ref. [1]), was used for VLBI data processing until Dec. 31, 2006. It was running under Fortran 90 on an HP workstation with an HP-UX11.00 operating system.

Independently of this, the Linux version of Calc/Solve, release 2006.07.19, revision 2006.09.26 (ref. [2]) was installed on another machine with an operating system GNU/Linux 2.6.5-7.97-smp for tests in parallel to the routine data analysis. The main difference between the two Calc/Solve versions is the new Calc 10 implementation in the Linux version for complying with the IAU 2000 Resolutions and the IERS Conventions 2003. 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, T2) and submitted them to the IVS Data Centers.

- **Scheduling**
  BKG continued scheduling the INT2 Intensive sessions on the baseline TSUKUBA-WETTZELL. Altogether 94 schedule files were created in 2006.

- **IVS EOP time series**
  The generation of the BKG EOP time series bkg00007 was continued. Every time after the preprocessing of any new VLBI session (correlator output database version 1), a new global solution with 24 hour VLBI sessions since 1984 was computed and the EOP time series bkg00007 was extracted for the IVS combination. Altogether 3379 sessions were 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 the VTRF2003 (ref. [4]) and no-net-rotation for 212 defining sources with respect to ICRF-Ext.1 (ref. [3]). The station coordinates of the stations CTVASTJ (Canada), DSS65A (Spain), METSAHOV (Finland), SVETLOE (Russia), ZELENCHK (Russia) were estimated as local parameters in each session.

  The UT1 time series bkgint04 was also continued. The observations of both baselines KOKEE-WETTZELL and TSUKUBA-WETTZELL, each with a duration of about 1-hour, were processed regularly. Series bkgint04 was generated with fixed TRF (VTRF2003) and fixed CRF derived from the global BKG solution for EOP determination. The estimated parameter types were only UT1, station clock, and zenith troposphere. A total of 2028 UT1 Intensive sessions were analyzed for the period between 1999.01.01 and 2007.01.07.

- **Quarterly updated solutions for submission to IVS**
  Also in 2006 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 bkg00007. 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 bkg00007.

- **Daily SINEX files**
  The VLBI group of BKG also continued the regular submissions of daily SINEX files for all available 24 hours 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 VTRF2003 and the fixed CRF derived from the global complete BKG solution for EOP determination is used for the a priori CRF information.

3. Research Topics

- **Singular Value Decomposition**
  It is well known that the VLBI technique is very sensitive to variations in both the network geometry and the observation geometry. As mentioned in the 'IVS-WG3 Report on Data Analysis' improved analysis strategies together with observation scheduling should be developed in order to reduce the effect of single observations on the results. One way of assessing the sensitivity of an adjustment problem is to analyse the design matrix of the corresponding least-squares problem by algebraic tools. At IGGB an objective and automatic analysis tool (or regression diagnostics tool) has been developed which helps to analyse the design matrix of a VLBI adjustment by so-called singular value decomposition. In order to find (groups of) important and less important (and thus negligible) observations, so-called cluster analysis methods are used. The results will be published in a Ph.D. thesis in 2007.

- **ITRF2005 Input Generation**
  For IVS' contribution to the ITRF2005 the IVS Analysis Coordinator's office at IGGB performed the intra-technique combination of more than 4100 sessions (data span: 1979 through 2005). For each session the data of up to five IVS Analysis Centers have been combined on the normal equation level and have been submitted to ITRF combination centres. Before the final combination, both internal and external comparisons with either the combined solution or with IGS- or C04-EOP-series have been performed. More details and results can be found in [5].

- **Analysis of water vapour radiometer data**
  Investigations of water vapour radiometer data have concentrated on the analysis of raw brightness temperature measurements from the broadband radiometer at Effelsberg.

- **Variance component estimation of IVS normal equation combination**
  In order to account for the different qualities of the individual contributions, i.e. individual normal equations, to the IVS normal equation combination, weighting factors have been determined. One way of determining weighting factors is to use variance component estimation. The basic idea of the variance component estimation is to compute individual variance factors for each group of observations instead of one common a posteriori variance factor. Here, a group of observations consists of an individual normal equation system for one session. The estimated variance factors can then be used for re-weighting each contribution.

- **Analysis of sub-daily ERP variations**
  First steps have been taken to generate time series of sub-daily ERP from VLBI observations on the basis of CONT05 sessions using Calc/Solve. This investigation uses a temporal resolution between 15 and 60 minutes. The main objective of the initial investigation is to find out how different parameterizations in the estimation process affect the target parameters in order to find an optimal setup for estimation of sub-daily ERP.

4. Personnel

Table 1. Personnel at BKG/IGGB Analysis Center

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References

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[3] ICRF-Ext.1 (http://hpiers.obspm.fr/webiers/results/Icrf)

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