The BKG/IGGB VLBI Analysis Center

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Abstract

In 2007 the activities of the BKG/IGGB (former GIUB, only renamed) 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 and the networks Kokee—Svetloe—Wettzell and Ny-Ålesund—Tsukuba—Wettzell. At the same time, new models have been implemented in the data analysis software and first contributions to the Working Group on ICRF2 were finished at BKG. At IGGB the emphasis was 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), formerly Geodetic Institute of the University of Bonn (GIUB). 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 SINEX files for 24-hour VLBI sessions and for 1-hour Intensive sessions as well as for 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 10, 2007 [1], 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 Calc/Solve software was modified for using the Vienna Mapping Function (VMF1). Applying VMF1 in data analysis requires a daily update of the VMF1 data from the server of the Technical University of Vienna [2]. 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 which are observed on the baseline TSUKUBA-WETTZELL. Altogether 100 schedule files were created in 2007.

- **IVS EOP time series**
  The new EOP time series bkg00010 differs from the previous one by several points. The data analysis was made with the new mapping function VMF1 for modeling the tropospheric delay correction. Mean pole offsets for pole tide were used to be in agreement with the IERS Conventions 2003 recommended values. The modeling for 3 stations was refined by non-linear site position variations estimation (GILCREEK, HRAS, PIETOWN). Furthermore the new official list of the VLBI antenna axis offsets, status May 17, 2007 [3] and the a priori VTRF2005 [4] were 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 bkg00010 was extracted. Altogether 3533 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 VTRF2005 and no-net-rotation for 212 defining sources with respect to ICRF-Ext.1 [5]. The station coordinates of the stations BADARY (Russia), CTVASTJ (Canada), DSS65A (Spain), METSAHOV (Finland), ZELENCHK (Russia) were estimated as local parameters in each session.

  VMF1 was used in the new UT1 time series bkgint07 too. 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, station clock, and zenith troposphere. A total of 2372 UT1 Intensive sessions were analyzed for the period between 1999.01.01 and 2008.01.07.

- **Quarterly updated solutions for submission to IVS**
  Also in 2007 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 bkg00010. 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 bkg00010.

- **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 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 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

- **ICRF2**
  The VLBI group at BKG is part of the IVS Working Group for the Second Realization of the ICRF. An important step is the computation of time series for all radio sources. On the basis of former investigations [6] a new set of time series for all radio sources was computed with nearly no change in datum definition. It is planned to investigate the long-term stability of radio sources based on the time series of radio source positions.
- **Subdaily EOP**
  The estimation of subdaily ERP from continuous VLBI campaigns show significant degradations at the session boundaries due to the breaks in observing time caused by the change-over time at the stations from one session to the next of approximately 30 minutes. As a consequence, high-frequency EOP time series with a resolution of less than two hours are disrupted showing severe jumps in the time series unless strong constraints are applied. In order to cope with this problem, a modified solution procedure for continuous VLBI campaigns was implemented. Here, two consecutive sessions are linked through a stacking of the respective elements of the normal equation matrix so that observations before and after the break contribute to the EOP parameters near the break.

  Furthermore, investigations of the impact of different analysis options on the target parameters have been continued. As one result, corrections to the recent precession-nutation model IAU2000a with values reported in the IERS C04 series have improved the results in terms of WRMS w.r.t. GPS solutions since the effect on the retrograde term with a period of one day is significantly reduced.
- **Stability of VLBI solutions**
  We investigated the impact of different analysis options on station positions. It turned out that the station position repeatability is improved up to 10% by applying thermal deformation and advanced troposphere modeling with VMF1 instead of using the NMF mapping

function. On the other hand no significant degradation could be detected by using ECMWF meteorological data instead of measured meteorological information to model the a priori dry hydrostatic zenith delay.

- **Singular Value Decomposition**
  At IGGB the development of a regression diagnostics tool has been completed which helps to analyze the design matrix of a VLBI adjustment by so-called singular value decomposition. With this tool observing schedules of one-hour Intensive sessions can be analyzed. In order to find (groups of) important and less important (and thus negligible) observations, so-called cluster analysis methods are used. The background and first results have been published in a Ph.D. thesis [7].

4. Personnel

Table 1. Personnel at BKG/IGGB Analysis Center

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References

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[3] VLBI antenna axis offsets 2007: (http://vlbi.geod.uni-bonn.de/IVS-AC/data/axis-offsets.txt).

[4] VTRF2005: (http://vlbi.geod.uni-bonn.de/IVS-AC/index.html).

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

[6] Engelhardt G., Thorandt V. (2006): First steps to Investigate Long-Term Stability of Radio Sources in VLBI Analysis. In: IVS General Meeting Proceedings 2006, Concepcion, Chile, edited by D. Behrend and K.D. Baver, NASA/CP-2006-214140, p.281-285.

[7] Vennebusch M.; Singular value decomposition and cluster analysis as regression diagnostics tools in geodetic VLBI; Ph.D thesis, Institute of Geodesy and Geoinformation Bonn, 2007, in press; electronic document: http://hss.ulb.uni-bonn.de/diss_online/landw_fak/2007/vennebusch_markus