The GIUB/BKG VLBI Analysis Center

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Abstract

This report describes the GIUB/BKG analysis center and discusses its data analysis and research activities for the reporting period.

1. General Information

The GIUB/BKG VLBI Analysis Center has been established jointly by the Bundesamt für Kartographie und Geodäsie (BKG), Leipzig, and by the Geodetic Institute of the University of Bonn (GIUB). Both institutions closely cooperate in the field of geodetic VLBI maintaining their own analysis groups in Leipzig and Bonn. The responsibilities include data analysis and software development. The BKG is responsible for the computation of earth orientation parameter (EOP) time series and annual solutions to be submitted to the International VLBI Service (IVS) and to the International Earth Rotation Service (IERS). The group at GIUB carries out special investigations in the field of geodetic VLBI in general and analyzes sessions correlated at the Bonn Correlator in particular.

2. Data Analysis

At BKG the Mark-IV data analysis software system CALC/SOLVE, release of June 5, 2001 (GSFC 2001) is currently used for VLBI data processing. In addition, an independent program environment for the CALC/SOLVE software has been developed for the pre- and post-interactive part of the EOP series determination. The CALC/SOLVE software is installed on a HP9000/280/1 workstation with the HP-UX10.20 operating system. The analysis activities of BKG can be divided in:

- **Processing of correlator output**
  The BKG group generated calibrated databases for the sessions correlated at the Bonn Astro/Geo Mark IV Correlator (e.g. IRIS-S, CORE-OHIG, EUROPE) and subsequently submitted them to the IVS Data Centers for distribution.
- **IVS EOP time series**
  The BKG group continued the EOP time series computation from 24 hour VLBI sessions and UT1 intensive sessions. From the beginning of 1984 to the end of 2001 altogether 2421 sessions of 24-hour observing time were processed (bkg00001). Also, 709 UT1 intensive sessions with about 1 hour measurement duration were analysed for the period between Jan. 1, 1999, to January 8, 2002 (bkgint01).
- **Annual solution for submission to IERS**
  A new combined global solution with a data span from January 1984 to December 2000 was computed for submission to IVS/IERS. The main parameters, i.e. station coordinates and velocities, radio source positions and EOP, were estimated in one global solution. The results of the EOP and radio source positions were submitted to IVS/IERS in IERS format. The

TRF solution is available in SINEX format (station coordinates, velocities, covariance matrix) and as normal equations including the global source parameters with a format devised at BKG.

3. Research Topics

- **Investigations of analysis setups**
  In addition to the standard EOP time series (bkg00001) a second EOP time series from 24-hour VLBI sessions was generated to investigate the effects of adding x- and y-pole rate parameters in the adjustment of the observations (bkg00002). Most differences between the EOP series bkg00001 and bkg00002 are smaller than their formal standard deviations of the adjustments.

  Test computations of the BKG EOP series with the ITRF2000 as apriori TRF were started for establishing of new EOP series early in 2002 (bkg00003, bkgint02). Comparisons of these new EOP with the IERS C04 series show a better agreement and appear to be more homogeneous than the current BKG EOP series.

  An independent assessment of the accuracy of the BKG EOP series is possible by a comparison between the results of the VLBI sessions of the NEOS and the CORE programme observed on the same days. Assuming that the offset between the EOP results from both series should, on average, be zero, RMS differences from pair-wise measurements (s1) can be estimated (Table 1). Based on these values the reliability of the formal errors (s2) can be checked. As a result it can be stated that the use of the ITRF2000 yields a better agreement with the formal standard deviations in contrast to the TRF Navy 1998-10 (USNO 1997).

Table 1. Mean standard deviations for EOP components derived from 32 NEOS and 32 CORE VLBI sessions on the same day (period from 1999 to 2000.5)

EOP component	Units	s1 bkg 00001	$s1_{new}$ bkg 00003	s2 bkg 00001	$s2_{new}$ bkg 00003	s1/s2	$s1_{new}$ $/s2_{new}$
UT1-UTC	msec	0.024	0.012	0.007	0.006	3.4	2.0
X pole	mas	0.32	0.28	0.15	0.16	2.1	1.7
Y pole	mas	0.38	0.16	0.12	0.13	3.2	1.2
$d\psi$	mas	0.36	0.34	0.18	0.19	2.0	1.8
$d\epsilon$	mas	0.13	0.13	0.07	0.07	1.9	1.9
mean						2.5	1.7

- **Development of VLBI data analysis tools**
  The BKG group established an integrated technological system to manage data flow and analysis tasks at the BKG IVS Data and Analysis Center in an automatic manner. The technological process is subdivided into four sub-processes *mi_and_in*, *pre_solve*, *int_solve*, *post_solve*, which are working together, and a monitoring process (*monitor*). The modules *mi_and_in* and *pre_solve* handle all necessary tasks to update the files at the BKG Data Center and at the BKG Operational Data Center as well as to prepare databases for the

interactive process (*int_solve*). The module *post_solve* is responsible for establishing the IVS analysis products, currently several EOP series, and all databases including miscellaneous files (weather and cable files, NGS files) for all sessions correlated at the Bonn Correlator. All activities are monitored to get feedback for the above-mentioned processes and for the analysts (THORANDT et al. 2001).

- **Correlator comparison**
  In order to investigate in greater detail the MK IV correlator performance, a 4-station IRIS-S session has been correlated twice. Two complete and fully independent correlations of the same IRIS-S sessions were carried out to establish the noise floor of the system. First results of the comparison have been published at the Second IVS General Meeting at Tsukuba from February 4–8, 2002 (NOTHNAGEL et al. 2002).

- **2nd IVS Analysis Pilot Project**
  The VLBI group of BKG participated in the Second IVS Analysis Pilot Project by contributing troposphere parameters for a period of two years from all NEOS-A sessions.

- **Correlations between estimated parameters**
  It is common experience that atmospheric effects and topocentric station height components should be highly correlated due to their similar dependence on the elevation angles of the individual observations. Tests have been carried out to verify this issue by investigating post fit correlation coefficients from several types of VLBI networks. Preliminary results indicate that, at least on the basis of the post fit correlation coefficients, the correlation of the topocentric station height component with the clock offset of the respective station dominates the covariance matrix.

- **Calibration of INTENSIVE observations with GPS troposphere results**
  In early 1999 twelve 1-hour sessions were observed within the Tsukuba–Wettzell UT1 Project for an intensive-type series of UT1 measurements. It is being investigated whether GPS derived wet delay information may contribute to the stability of the UT1 determinations carried out in this project.

- **Automation of the VLBI data analysis procedure**
  An interface between the Mark-IV data analysis software system CALC/SOLVE and a Knowledge-Based System (KBS) has been developed. The KBS contains knowledge about the VLBI data analysis procedure and can be applied to automate data analysis of individual sessions within SOLVE. In addition, the Mark-IV data analysis software system has been extended in order to automate those steps of data analysis needed to prepare a database for the analysis within SOLVE. Detailed information about the software developments can be found in Schwegmann, 2002.

4. Personnel

Table 2. Personnel at GIUB/BKG Analysis Center

Gerald Engelhardt	BKG	
Dorothee Fischer	GIUB	from 09/2001
Axel Nothnagel	GIUB	
Wolfgang Schwegmann	GIUB	from 10/2001
Christoph Steinforth	GIUB	
Volkmar Thorandt	BKG	
Dieter Ullrich	BKG	
Reiner Wojdziak	BKG	

References

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