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Activities of the IVS Analysis Center at BKG in 2003

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Abstract

The main analysis activities at the International VLBI Service (IVS) Analysis Center at BKG can be divided into the processing of the correlator output, the producing of two Earth Orientation Parameter (EOP) time series for submission to the IVS, the regular submissions of tropospheric parameters for the IVS-R1 and IVS-R4 sessions, and the generating of daily SINEX (Solution INdependent EXchange format) files for the IVS.

For the IVS products Terrestrial Reference Frame (TRF) and Celestial Reference Frame (CRF) quarterly updated solutions are computed. The main features of these works are explained and some results are compared to the official IERS (International Earth Rotation and Reference Systems Service) products.

A UT1 time series derived from about 1-hour measurements of the baseline TSUKUBA-WETTZELL was generated and first results of the data processing were compared with the results of the official BKG UT1 time series derived from data of the baseline KOKEE-WETTZELL. The measurements of the new station TIGOCONC (Conception, Chile) have been used in the processing for about 1.6 years. So first velocity information about this station could be estimated from the station coordinate series. The use of unstable sources identified by Martine Feissel-Vernier [1] was tested and comparisons were made with the results of the routinely used procedure for the EOP determination of the BKG VLBI group.

1. General Information

The IVS Analysis Center at BKG is responsible for the computation of EOP time series, quarterly updated global solutions for the TRF and CRF, the estimation of tropospheric parameters of the IVS-R1 and IVS-R4 sessions, and the generating of daily SINEX files.

The VLBI group at BKG continued the generation of calibrated databases for the sessions correlated at the MPIfR (Max-Planck-Institut für Radioastronomie)/BKG Mark 5 Astro/Geo Correlator at Bonn (e.g. R1, T2, OHIG, EURO) and submitted them to the IVS Data Centers for distribution. After the preprocessing only one global solution is computed for the extraction of the EOP, tropospheric parameters, TRF, and CRF. The producing of the UT1 time series for intensive observations and the generating of daily SINEX files are based on independent session solutions.

At BKG the Mark 5 VLBI data analysis software system Calc/Solve, release of September 25, 2003 [2], is currently used for VLBI data processing. In addition, the older Mark IV version, release of May 15, 2003 and an independent program environment for the Calc/Solve software are available. The latter is used for the data and product handling outside of Calc/Solve. The Mark IV Calc/Solve software under Fortran77 is installed on a HP9000/280/1 workstation with an HP-UX10.20 operating system and the Mark 5 software under Fortran90 on another HP workstation with an HP-UX11.00 operating system.

2. Data Analysis for the IVS

2.1. BKG Time Series bkg00006

The currently generated EOP time series bkg00006 is extracted from a global solution with 24 hours VLBI sessions from 1984 on. Altogether 2902 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 are applied to get zero net rotation and net translation for 26 selected station positions and velocities with respect to the VTRF2003 [5] and zero net rotation for 212 defining sources with respect to ICRF-Ext.1 [3]. The station coordinates of the stations TIGOCONC (Chile) and SVETLOE (Russia) are estimated as local parameters in each session.

2.2. BKG Time Series bkgint03

The UT1 time series bkgint03 from intensive observation sessions of the baseline KOKEE-WETTZELL each with a duration of about 1 hour is generated with fixed TRF (VTRF2003) and fixed CRF derived from the global BKG solution for EOP determination. The estimated parameter types are only UT1, station clock, and zenith troposphere. Currently altogether 1088 UT1 intensive sessions were analysed for the period between 1999.01.01 and 2004.01.26.

2.3. Quarterly Updated Solutions

For the IVS products TRF and CRF quarterly updated solutions are estimated. There are no differences in the solution strategy compared to the continuously computed EOP time series bkg00006. The results are formatted to IERS format for the radio source positions and SINEX format, version 2.1 for the station coordinates and velocities.

2.4. Tropospheric Parameters

The VLBI group of BKG has started regular submissions of tropospheric parameters to the IVS (wet and total zenith delays, horizontal gradients) for all IVS-R1 and IVS-R4 sessions since January 1, 2002. 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 bkg00006. In future the submission of a long time series of tropospheric parameters from 1984 on is planned.

2.5. Daily SINEX Files

The VLBI group of BKG has started regular submissions of daily SINEX files as base solutions for the planned IVS time series of baseline lengths and for combination techniques. In addition to the global solutions independent session solutions are computed for the parameter types station coordinates, EOP, and nutation parameters.

3. Special Computations

Besides the routine data analysis for the IVS special computations with respect to a new UT1 time series, station data of TIGOCONC, and unstable radio sources were made.

3.1. UT1 Time Series from 1-Hour Data TSUKUBA-WETTZELL

A new UT1 time series from intensive observation sessions based on K4 technology of the baseline TSUKUBA-WETTZELL each with a time span of about 1 hour was generated. Altogether 20 sessions from 2002.07.01 to 2002.12.19 and 28 sessions from 2003.04.12 to 2003.12.20 were analyzed. The processing strategy was identical to the routine computations of the UT1 time series bkgint03. The results are listed in Table 1.

Table 1. Results of the new UT1 intensive series TSUKUBA-WETTZELL in comparison with the standard UT1 intensive series KOKEE-WETTZELL

Topic	Data based on K4 technology TSUKUBA-WETTZELL	bkgint03 KOKEE-WETTZELL
Number of observations 2002.07.01-2003.12.20	48	270 resp. 51 (∗)
WRMS derived from the differences to C04 in UT1-UTC	19.3 μs	12.8 μs resp. 11.4 μs
Mean formal standard deviation from Solve in UT1-UTC	8.6 μs	15.6 μs resp. 12.1 μs

(∗) only epochs from data TSUKUBA-WETTZELL, range of about half a day

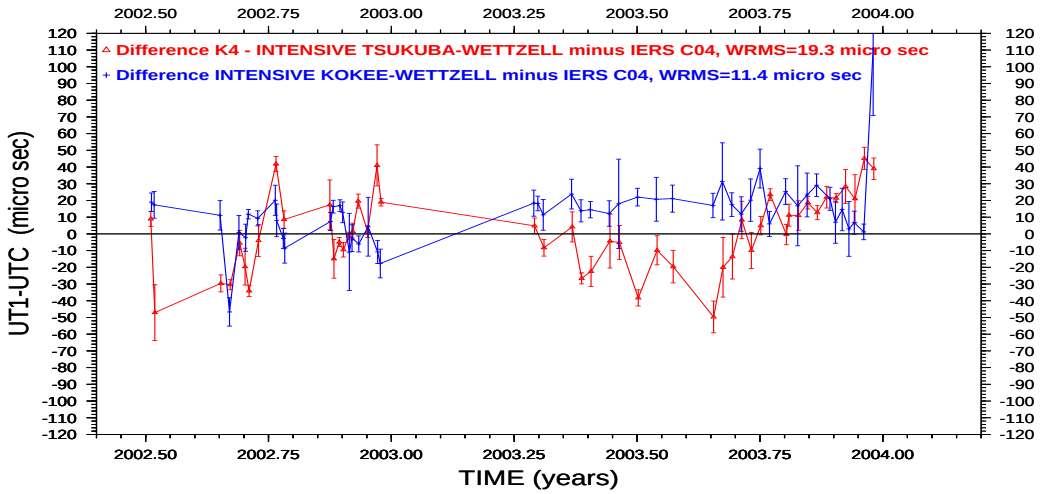

Figure 1. Residuals of TSUKUBA-WETTZELL and KOKEE-WETTZELL UT1-UTC intensive series w.r.t. IERS C04

It can be stated that the new UT1 time series from TSUKUBA-WETTZELL data shows more scatter w.r.t. IERS CO4 series [4] although the mean formal standard deviation of UT1-UTC from Solve is better than the one from the standard series bkgint03 (see Figure 1). Nevertheless the new series is compatible to the series from KOKEE-WETTZELL data and can be used to control it.

3.2. Results from 1.6 Years Data of Station TIGOCONC (Chile)

At the new transportable fundamental station for geodesy in South America TIGOCONC located near of Conception in Chile VLBI data has been observed since May 13, 2002. In the global BKG solution for the extraction of the EOP (bkg00006) coordinate series of TIGOCONC were determined from 2002.05.13 to 2004.01.05. By using a straight-line model for fitting the TIGOCONC coordinate series, useful velocity information about the North, East, and Up component of station TIGOCONC could be estimated. The results are listed in Table 2.

Table 2. Station velocities of TIGOCONC derived from 1.6 years coordinate series in comparison with the global estimated velocities of SANTIA12

Solution from bkg00006	Station velocity mm/year	Standard deviation mm/year	WRMS mm
TIGOCONC N-component	13.7	1.9	13.0
TIGOCONC E-component	27.7	1.3	8.1
TIGOCONC U-component	9.0	4.4	21.0
SANTIA12 N-component	15.4	0.5	
SANTIA12 E-component	19.3	0.4	
SANTIA12 U-component	4.6	1.3	

On closer inspection of the standard deviations the estimated velocity information of station TIGOCONC are all significant. The station velocities of station SANTIA12 only 462 km north of TIGOCONC on the same South American plate make possible a plausibility control of the estimated velocities of TIGOCONC. The largest difference is 8 mm/year in the East component and could be explained by the fact that both stations are located on the plate boundary.

The accuracy (WRMS) derived from a straight-line model for fitting the session-wise determined baseline lengths from each baseline with TIGOCONC, also called baseline length repeatability, is about 2 ppb.

3.3. Test of Unstable Radio Sources

Test basis for the analysis of unstable radio sources was the paper by Martine Feissel-Vernier [1], table 6 with 162 unstable radio sources and stability criterion 3 or 4 included in it. In a first approximation the analysis strategy was set to a linear rate estimation in right ascension and declination of 162 unstable sources. So 162 unstable radio source positions were estimated as global parameters with their proper motions together with the no-net-rotation condition of sources w.r.t. ICRF-Ext.1 for 81 stable defining sources marked in the ICRF-Ext.1 catalogue in contrast to the routine global solution (bkg00006). The results prove that about 41 percent of the investigated sources show significant source proper motion with an amount of more than a triple standard

deviation of proper motion (Table 3).

Table 3. Results of the linear rate estimation of unstable radio sources

	Source motion more than 3× standard deviation	Source motion more than 2× standard deviation
No. of sources for RA+DEC	24	32
No. of sources for RA or DEC	42	61
Total	66	93
(including defining sources)	(19)	(34)

An example for the estimation of source proper motions is the defining source 2145+067 (1814 sessions from 1984-2003 with 67881 observations) with a right ascension velocity of -28 ± 0.9 $\mu as/year$ and a declination velocity of 12 ± 1.3 $\mu as/year$.

To study the effect of modelling of source proper motion with respect to the estimated EOP a comparison was made with IERS C04. Bias and WRMS derived from the differences to C04 are only slightly changed compared to the EOP from the standard global solution bkg00006. But the biases relative to C04 for the nutation parameters dPsi and dEps are more changed compared to polar motion parameters and UT1-UTC.

3.4. Outlook

The VLBI group at BKG will continue the refining of the solution strategy for series bkg00006. Topics for this are the estimation of axis offsets, the use of a new atmosphere model based on the VMF (Vienna Mapping Functions), and the handling of unstable radio source positions. Other works are the continuation of the UT1 time series from 1 hour data TSUKUBA-WETTZELL and the extension of the graphics module REPA [6].

References

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