Federal Agency for Cartography and Geodesy

VLBI Analysis at BKG

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Abstract

The VLBI group of the Federal Agency for Cartography and Geodesy (BKG) in Leipzig is part of the jointly operated IVS Analysis Center of BKG and the Institute for Geodesy and Geoinformation of the University of Bonn (IGGB). BKG is responsible for regular submissions of time series of Earth Orientation Parameters (EOP) and tropospheric parameters, the generation of daily SINEX (Solution INdependent EXchange format) files for 24-hours sessions and Intensive VLBI sessions, quarterly updated solutions to produce terrestrial and celestial reference frame realizations (TRF, CRF), and generating Intensive schedules (mainly Tsukuba-Wettzell). Additionally, the BKG Analysis Center has generated input in the form of daily SINEX files for the ITRF2014 VLBI combination solution. The data processing steps are explained and also some activities in the technologies of data analysis are pointed out.

1. General Information on Data Analysis

At BKG, the Mark 5 VLBI data analysis software system Calc/Solve, release 2014.02.21 [1], has been used for VLBI data processing. It is running on a Linux operating system.

Calc/Solve allows to generate so-called TRP files derived from the Vienna Mapping Function (VMF1) data. They contain external information about the troposphere on a scan-by-scan basis, specifically the a priori delay, dry and wet mapping functions, and gradient mapping functions. The BKG VLBI group uses TRP files to input data related to VMF1. The VMF1 data were downloaded daily from the server of the Vienna University of Technology.

Additionally, the technological software environment for Calc/Solve has been refined to link the Data Center management with the pre- and post-interactive parts of the EOP series production and to monitor all Analysis and Data Center activities (Figure 1 and Figure 2).

2. Processing of Correlator Output

One important task in data analysis at BKG is the generation of calibrated databases for the sessions correlated at the MPIfR/BKG Astro/Geo Correlator at Bonn (e.g. EURO, OHIG, T2) and submitted them to the IVS Data Centers.

3. Scheduling

BKG is responsible for scheduling the INT2 Intensive sessions, which are observed on the TSUKUBA-WETTZELL baseline by using the program system SKED developed by John Gipson (NVI, Inc/NASA Goddard Spaceflight Center).

Due to maintenance of the TSUKUBA antenna in 2014, two schedule files for baseline KASHIM34-WETTZELL were also made available.

4. IVS EOP Time Series bkg00014

The BKG EOP time series bkg00013 was replaced by the new one bkg00014. One main difference to the former solution was the use of the IERS2010 conventions. The solution for generating the EOP series based on a global solution mode with common estimation of all parameter types. The EOP are one part of the arc-parameters, i.e. estimations for each experiment session. The global parameter adjustments refer to the entire data set, e.g. station positions and velocities or source positions.

Each new VLBI session issued from correlator as database version 1 is processed and after that a new global solution with 24-hours sessions since 1984 is computed. Then the EOP time series bkg00014 is extracted.

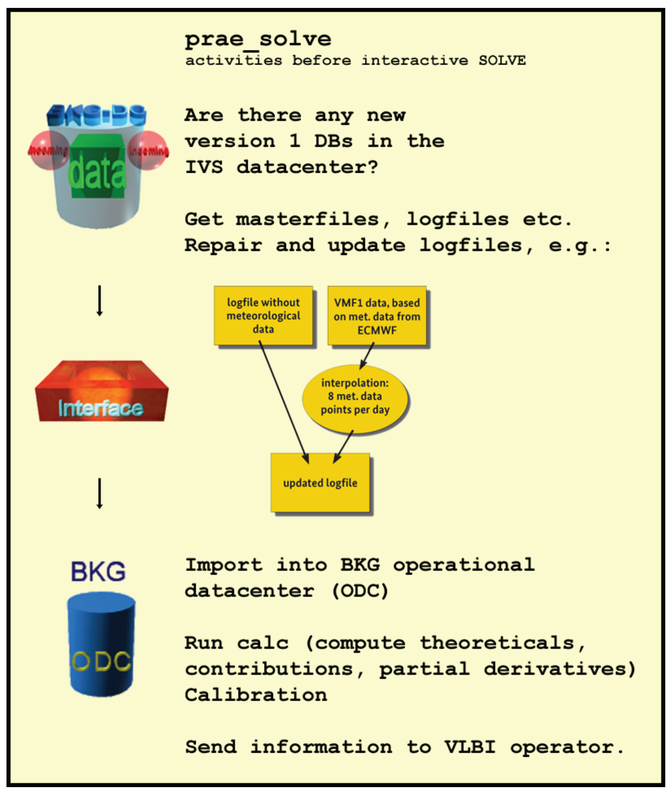

Figure 1: Activities before interactive SOLVE, prae_solve

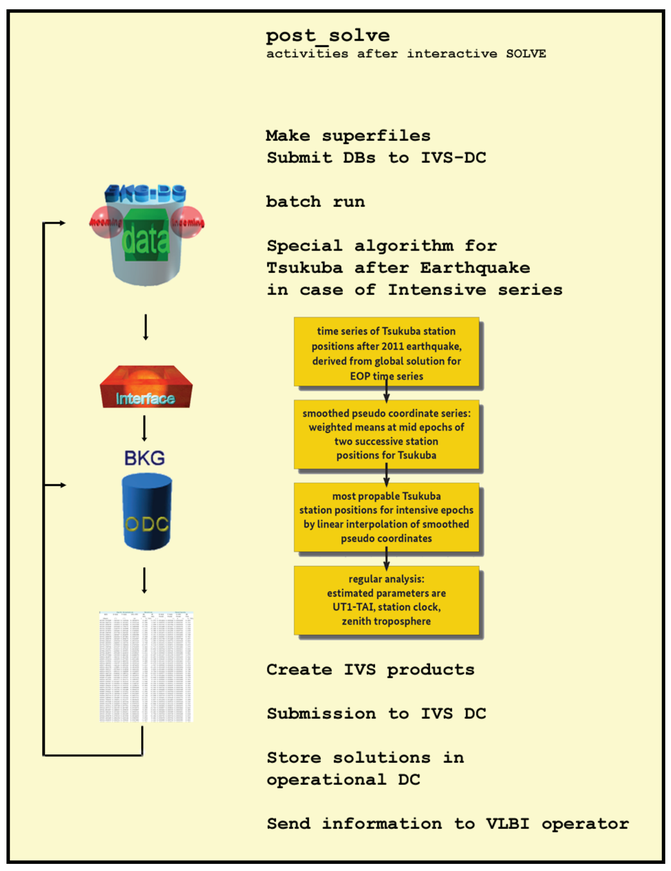

Figure 2: Activities after interactive SOLVE, post_solve

Some topics of solution bkg00014 are:

- number of sessions more than 4788,
- datum definition is realized by applying no-net-rotation and no-net-translation conditions for 25 selected station positions and velocities with respect to VTRF2008a and no-net-rotation condition for 295 defining sources with respect to ICRF2,
- global parameter types station coordinates and velocities, radio source positions
- local parameter types in each session, e.g. EOP, tropospheric parameters (zenith wet delays at 1 hour intervals), coordinates of some unstable or infrequently observed sources, local station coordinates for AIRA (Japan), CHICHI10 (Japan), CTVASTJ (Canada), DSS13 (USA), HART15M (South Africa), KASHIM11 (Japan), KASHIM34 (Japan), KOGANEI (Japan), KUNMING (China), PT_REYES (USA), RAEGYEB (Spain), SEJONG Korea), SEST (Chile), SINTOTU3 (Japan), TIANMA65 (China), TIGOCONC (Chile), TSUKUB32 (Japan), UCHINOUR (Japan), VERAISGK (Japan), VERAMZSW (Japan), WIDE85_3 (USA), and YEBES40M Spain).

Furthermore the fact of unavailable meteorological data in station logfiles could be compensated by using of meteorological data from European Centre for Medium-Range Weather Forecasts (ECMWF) contained in VMF1 data files.

This procedure was integrated in the technological process of the EOP series generation.

5. IVS UT1 Time Series bkgint14

The UT1-UTC time series bkgint09 was replaced by bkgint14 in consideration of the IERS2010 conventions. The series bkgint14 based on independent session solutions with fixed TRF (VTRF2008a) and fixed ICRF2. The a priori EOP are taken from final USNO series [2]. The estimated parameter types are only UT1-TAI, station clock, and zenith troposphere. The algorithms of the semi-automatic process for handling the Intensive sessions Int2/3 with station TSUKUBA after the Japan earthquake [3] have been further used, i.e. before the regular analysis can be started most probable station positions of TSUKUBA for the epochs of Int2/3 sessions have to be estimated.

6. Quarterly Updated TRF and CRF Solutions for Submission to IVS

Every year quarterly updated solutions for the IVS products TRF and CRF are computed. There are no differences in the solution strategy compared to the continuously computed EOP time series bkg00014. The results of the radio source positions are 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.

7. Tropospheric Parameters

The VLBI group of BKG continues regular submissions of long time series of tropospheric parameters to the IVS (wet and total zenith delays, horizontal gradients) for all available VLBI sessions since 1984. The tropospheric parameters are extracted from the standard global solution for the EOP time series bkg00014 and transformed into SINEX format.

8. Daily SINEX Files

In addition to the global solutions, daily SINEX files for all available 24-hours sessions as base solutions for the IVS time series of baseline lengths and for combination techniques are submitted. Independent session solutions (bkg2014a.snx) are computed for the parameter types station coordinates, radio source coordinates except for 295 defining sources of ICRF2, and EOP including the X,Y-nutation parameters. The a priori datum for TRF is defined by the VTRF2008a, and ICRF2 is used for the a priori CRF information.

9. SINEX Files for Intensive Sessions

IVS SINEX files for Intensive sessions (bkg2014a.sni) are created and submitted to IVS. The parameter types are station coordinates, pole coordinates and their rates, and UT1-TAI with rate. Only the normal equations stored in the SINEX files are important for further intratechnique combination or combination with other space geodetic techniques.

References

[1] GSFC, NASA (2014): Release of Mark 5 VLBI Analysis Software Calc/Solve from February 21, 2014 (Web reference: http://gemini.gsfc.nasa.gov/solve).

[2] USNO (2014): Earth orientation parameters series from finals USNO series 2014, (Web reference: http://gemini.gsfc.nasa.gov/500/oper/solve_apriori_files/usno_finals.erp).

[3] Engelhardt G., Thorandt V., Ullrich D. (2013): Rapid UT1 Estimation Derived from Tsukuba VLBI Measurements after 2011 Earthquake. In: Proceedings of the 21st Meeting of the European VLBI Group for Geodesy and Astronomy 2013, edited by N. Zubko and M. Poutanen, page 85-87, Kirkkonummi 2013, Finland.

Further Information

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