DGFI-TUM Analysis Center Biennial Report 2017+2018

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Abstract This report describes the activities of the DGFI-TUM Analysis Center (AC) in 2017 and 2018. Besides regular IVS submissions, DGFI-TUM continued to reprocess past 24-hour sessions including the estimation of source positions. Starting in 2017, we have adopted DOGS-RI as the VLBI analysis software after successful internal/external validation.

1 General Information and Component Description

DGFI-TUM has been acting as an IVS AC since the establishment of the IVS in 1999. Starting from November 2008, we are an operational AC regularly submitting datum-free normal equations for 24-hour sessions in the SINEX format. Since 2008, we have also been involved in the BKG/DGFI-TUM Combination Center by maintaining the combination software.

DGFI-TUM is an institute of the Technische Universität München (TUM) since January 2015 and is located in the city center of Munich, Germany. The research performed at DGFI-TUM covers many different fields of geodesy (reference systems, satellite altimetry, Earth system modelling, etc.) and includes contributions to national and international scientific services and research projects, as well as various functions in scientific organizations (see http://www.dgfi.tum.de).

Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM)

DGFI-TUM Analysis Center

IVS 2017+2018 Biennial Report

2 Staff

In March 2017, Younghee Kwak took over the operational IVS analysis from Ralf Schmid, who left DGFI-TUM at that time. Michael Gerstl and Matthias Glomsda (who joined the institute in April 2017) are in charge of the development of our proprietary VLBI analysis software DOGS-RI (DGFI Orbit and Geodetic parameter estimation Software - Radio Interferometry). Table 1 lists the staff members and their main areas of activity.

Table 1 Staff members and their main areas of activity.

Detlef Angermann	Group leader.
Michael Gerstl	Develoment of the analysis software DOGS-RI.
Matthias Glomsda	Develoment of the analysis software DOGS-RI; operational data analysis (starting 2019).
Younghee Kwak	Operational data analysis (2017-2018); CRF/TRF combination; combination of different space geodetic techniques.
Manuela Seitz (returned from maternity leave in December 2018)	CRF/TRF combination; combination of different space geodetic techniques.
Ralf Schmid (left in March 2017)	Operational data analysis.

3 Current Status and Activities

Analysis Activities

In 2017 and 2018, we had a lot of changes in our solutions. In March 2017, the submission of VLBI solutions processed with OCCAM@DGFI was suspended. After thorough internal/external validation [1], our new in-house VLBI software, DOGS-RI, was launched and started to contribute a new IVS solution (dgf2018a). The performance of DOGS-RI is equal to or even better than OCCAM@DGFI. A processing of old sessions backward until 1984 was conducted. Table 2 contains a summary of all sessions analyzed with DOGS-RI.

The implementation of reading vgosDB in DOGS-RI has also been a big evolvement. The IVS decided to provide correlated VLBI data only in vgosDB format starting from October 1, 2018. Therefore, every AC had to be ready to handle vgosDB within its analysis software. Since vgosDB is based on netCDF and the structure of the data has also been reconstructed entirely, the subroutines for input data reading had to be thoroughly revised.

Table 2 Sessions processed in 2017 and 2018.

Year	vgosDB	Total (NGS + vgosDB)
1984-1990	-	629
1991-2000	-	1328
2001-2010	-	1428
2011-2017	-	1052
2018	33	96

Software Development

The processing with DOGS-RI is on track, but there are always new developments that have to be implemented to keep the software up-to-date and meet the intended accuracy goals. Furthermore, a major enterprise is to fully consolidate DOGS-RI with the other components of DOGS, OC (Orbit Computation) and CS (Combination & Solution), to share common routines and upgrade to a more flexible data format. Another important innovation will be the integration of the recently established new International Celestial Reference Frame (ICRF3), which for the first time makes use of Galactic Aberration, i.e., the proper motions of radio sources. In anticipation of the next International Terrestrial Reference Frame (ITRF2020), it will also be necessary to account for the gravitational deformation of VLBI telescopes. Other projects are the inclusion of more non-tidal loading effects, the treatment of source structure, and the completion of a simulation mode.

Consistent Realization of CRF and TRF

The IUGG urged "that highest consistency between the ICRF, the ITRF, and the EOP as observed and realized by the IAG and its components such as the IERS should be a primary goal in all future realizations of the ICRS", according to Resolution No. 3 of the IUGG adopted by the General Assembly in 2011.

As a research of consistent realization of the CRF and the TRF in accordance with the IUGG Resolution, DGFI-TUM conducted a project "Consistent celestial and terrestrial reference frames by improved modelling and combination" as part of the DFG Research Unit FOR1503, "Space-time reference systems for monitoring global change and for precise navigation in space".

For the consistent realization, VLBI, GNSS, and SLR single-technique solutions of 11 years (2005.0–2016.0) were processed homogeneously and combined on the normal equation level. Several types of combined solutions were computed following the selections of different local ties (LTs), EOP combination setups, and different weights of the techniques. Finally, the impact of these combination setups on CRF, TRF, and EOP was investigated. The main conclusions are as follows (more details can be found in [2]):

- The combination of different space geodetic techniques improves the precision of the estimated parameters due to the larger number of observations.
- The selection of the LTs mostly affects the TRF.
- The CRF benefits from the precise terrestrial x/y-pole coordinates estimated by GNSS.
- The combination of ΔUT1 from VLBI and the satellite techniques impacts the right ascension and thus the CRF z-rotation (Figure 1).
- Emphasizing satellite techniques (down-weighting VLBI observations) significantly influences the

CRF and causes systematic rotations of the source positions.

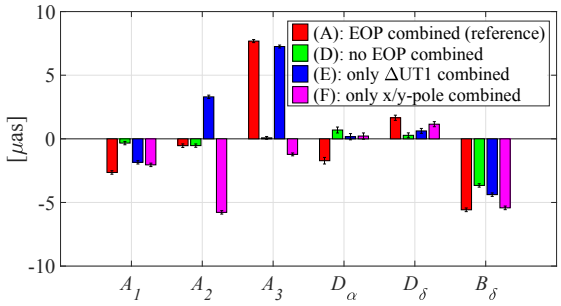

Fig. 1 CRF transformation parameters and their standard deviations (error bars) of different EOP combination setups w.r.t. the VLBI-only solution [2]. A1, A2, and A3 denote the rotations between two CRFs w.r.t. the three axes, D_α and D_δ represent the drifts of right ascension and declination, and B_δ means a bias in declination.

4 Future Plans

In 2019, we will continue to submit solutions to the IVS, but the persons in charge will change (see Table 1). There will be a new DGFI-TUM solution tag when the planned software enhancements have been implemented. The IVS Combination Center at BKG might introduce the combination of Intensive sessions, and consequently we might extend our IVS contribution to Intensives as well. Finally, of course, we want to take part in the data generation for ITRF2020.

References

1. Kwak Y., Gerstl M., Blossfeld M., Angermann D., Schmid R., Seitz M. (2017) DOGS-RI: new VLBI analysis software at DGFI-TUM. In: Haas R., Elgered G. (eds.) Proceedings of the 23rd EVGA Meeting, 212–215
2. Kwak Y., Blossfeld M., Schmid R., Angermann D., Gerstl M., Seitz M. (2018) Consistent realization of celestial and terrestrial reference frames. J Geod, doi:10.1007/s00190-018-1130-6