DGFI-TUM Analysis Center Biennial Report 2015+2016

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Abstract This report presents the activities of the DGFI-TUM Analysis Center in 2015 and 2016. Besides regular IVS submissions, DGFI-TUM continued to reprocess 24-hour sessions including the estimation of source positions. DOGS-RI, the new VLBI analysis software to be used at DGFI-TUM, exhibited promising results in the VLBI Analysis Software Comparison Campaign 2015 (VASCC2015). First analyses of DOGS-RI SINEX files by the IVS Combination Center revealed a reasonable agreement with the IVS combined solution for recent sessions. Before switching to the new software, a long-term solution has to be analyzed.

1 General Information and Component Description

The DGFI-TUM Analysis Center (AC) is located at the German Geodetic Research Institute (Deutsches Geodätisches Forschungsinstitut der Technischen Universität München) in the city center of Munich in Germany. Having been an autonomous and independent research institution before, DGFI became an institute of the Technische Universität München (TUM) in January 2015 and is now called "DGFI-TUM".

Research performed at DGFI-TUM covers many different fields of geodesy (reference systems, satellite altimetry, Earth system modeling, etc.) and includes

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contributing to national and international scientific services and research projects as well as various functions in scientific organizations (see http://www.dgfi.tum.de).

DGFI-TUM has been acting as an IVS AC since the establishment of the IVS in 1999. Since November 2008, DGFI-TUM has been an operational AC regularly submitting constraint-free normal equations for 24-hour sessions in the SINEX format. Since 2008, DGFI-TUM has also been involved in the BKG/DGFI Combination Center.

2 Staff

In May 2016, Younghee Kwak joined the DGFI-TUM AC to support the combined estimation of celestial and terrestrial reference frames (CRF/TRF).

Table 1 Staff members and their main areas of activity.

Dr. Detlef Angermann	Group leader
Dr. Michael Gerstl	Development of the analysis software DOGS-RI
Dr. Younghee Kwak	CRF/TRF combination, combination of different space geodetic techniques
Dr. Ralf Schmid	Routine data analysis, combination of different space geodetic techniques
Dr. Manuela Seitz (currently on maternity leave)	CRF/TRF combination, ICRF3, combination of different space geodetic techniques

Ralf Schmid has been taking care of the routine analysis of 24-hour sessions since the end of May

2013. In addition, Michael Gerstl is engaged in the development of a new VLBI analysis software called DOGS-RI (DGFI Orbit and Geodetic Parameter Estimation Software - Radio Interferometry). Table 1 lists the staff members and their main areas of activity.

3 Current Status and Activities

Analysis Activities

In 2015 and 2016, the DGFI-TUM AC continued to re-analyze 24-hour sessions including the estimation of source positions. Still using the analysis software OCCAM, the period from March 2003 to April 2008 could be covered. This means that, at the end of December 2016, consistent DGFI SINEX files (dgf2009a) were available from March 2003 to December 2016.

If operational and reprocessed solutions are summed up, DGFI-TUM analyzed 1,028 sessions altogether from twelve different years and submitted the corresponding daily SINEX files to the IVS. Among them were, e.g., 364 IVS-R4, 362 IVS-R1, 60 IVS-R&D, 60 VLBA, 47 IVS-T2, 35 IVS-OHIG, 33 EUROPE, 15 CONT05, and the eight VCS-II sessions (see Table 2).

The reprocessed DGFI-TUM solutions as of January 2004 were considered for an analysis of combined source positions by the IVS Combination Center [1]. DGFI-TUM could demonstrate comparatively low WRMS values resulting from source position time series. This is probably due to the fact that sources with fewer than four observations in one session were not considered. Moreover, sources with large deviations from the a priori values or large standard deviations were also eliminated from the session-wise solutions.

Software Development

After several years of implementation, DOGS-RI is close to becoming operational. After detailed internal comparisons with OCCAM, DOGS-RI participated in the VLBI Analysis Software Comparison Campaign 2015 [2] on the basis of computed theoretical delays. DOGS-RI was among the six software packages that could achieve a sub-mm agreement in terms of RMS differences.

A set of SINEX files for sessions in 2016 generated by a new SINEX interface was provided to the IVS Combination Center. An initial nutation bias could be related to an inconsistency between the nutation parameters contained in the SINEX files of different ACs. Obviously, some ACs still provide the total nutation angles instead of corrections w.r.t. the a priori model. To avoid further confusion, DGFI-TUM SINEX files will contain zero a priori nutation values.

After the nutation problem was fixed, the session-wise DOGS-RI solutions showed a reasonable agreement with the IVS combined solution. To rule out systematic long-term effects, it is the intention to reprocess data back to 2003 using the OCCAM preprocessing options (clock breaks, excluded stations, excluded sources, outliers, etc.).

Consistent realization of CRF and TRF

For a consistent realization of CRF and TRF, DGFI-TUM prepared multi-year solutions of VLBI, GNSS, and SLR covering the period between 2005.0 and 2016.0 (11 years, see Table 3). The session-wise VLBI solutions were analyzed with OCCAM, and the global multi-year solution was generated with DOGS-CS. In the multi-year VLBI-only solution, a declination bias w.r.t. ICRF2 is visible for southern sources that could also be detected by other ACs (see Figure 1).
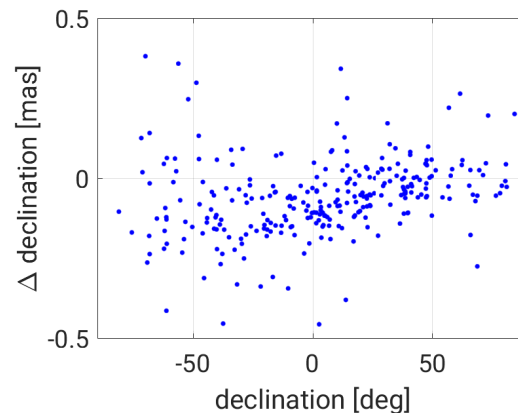

Fig. 1 Declination differences between the DGFI-TUM VLBI-only solution and the ICRF2 for defining sources.

Table 2 Sessions analyzed with OCCAM in 2015 and 2016.

Session type	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
AOV	–	–	–	–	–	–	–	–	–	–	–	–	2	2	4
APSG	2	2	2	2	2	–	–	–	–	–	–	–	2	1	13
AUS	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2
CONT05	–	–	15	–	–	–	–	–	–	–	–	–	–	–	15
EUROPE	3	3	3	6	6	–	–	–	–	–	–	1	6	5	33
IVS-CRF	3	1	2	1	2	–	–	–	–	–	–	–	–	3	12
IVS-E3	1	6	4	1	–	–	–	–	–	–	–	–	–	–	12
IVS-OHIG	–	2	3	6	7	3	–	–	–	–	–	6	6	2	35
IVS-R1	40	52	49	52	51	15	–	–	–	–	–	3	52	48	362
IVS-R4	39	51	50	51	52	15	1	–	–	–	1	8	52	44	364
IVS-R&D	8	4	10	10	9	3	–	–	–	–	1	6	6	3	60
IVS-T2	6	12	6	6	4	2	–	–	1	–	–	1	5	4	47
QUAKE	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
VCS-II	–	–	–	–	–	–	–	–	–	–	–	6	2	–	8
VLBA	7	11	13	8	7	2	–	–	–	–	–	1	6	5	60
Total	109	144	157	144	140	40	1	–	1	–	2	32	140	118	1028

Table 3 Multi-year (2005.0–2016.0) VLBI, GNSS, and SLR solutions.

	VLBI	GNSS	SLR
Institution	DGFI-TUM	CODE [3]	DGFI-TUM
Software	OCCAM	Bernese	DOGS-OC
Resolution	session-wise	daily	weekly
Datum conditions (station coordinates)	NNR/NNT	NNR/NNT/NNS	NNR
Datum conditions (source coordinates)	NNR	—	—
Coordinate jumps	according to DTRF2014 processing		

ICRF3

DGFI-TUM is represented in the IAU Working Group "Third Realization of International Celestial Reference Frame" (ICRF3) and intended for a combination of the ICRF3 solution from VLBI with GNSS and SLR. Although the ICRF3 solution resulting from a VLBI intra-technique combination is not ready yet, the combination strategy has already been prepared and tested. It mainly follows the procedure used for the consistent realization of CRF and TRF (see above).

4 Future Plans

In 2017, we intend to generate a DOGS-RI long-term solution. If the agreement with the IVS combined solution is satisfying, DGFI-TUM could switch from OCCAM to DOGS-RI. Besides, the inter-technique combination of VLBI, GNSS, and SLR for a consistent realization of CRF and TRF will be completed. As soon as a preliminary ICRF3 solution is available, we will combine it with other space geodetic techniques.

References

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