DGFI Analysis Center Annual Report 2012

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Abstract

This report summarizes the activities of the DGFI Analysis Center in 2012 and outlines the planned activities for 2013.

1. General Information and Component Description

The German Geodetic Research Institute (Deutsches Geodätisches Forschungsinstitut, DGFI) is an independent research institute hosted at the Bavarian Academy of Sciences and Humanities (BAdW) in Munich, Germany. It is directly funded by the Free State of Bavaria. The research covers all fields of geodesy and includes participation in national and international projects and working groups, as well as functions in international bodies (http://dgfi.badw.de). The Institut für Astronomische und Physikalische Geodäsie (IAPG) and the Forschungseinrichtung Satellitengeodäsie (FESG)(including FESG personnel at the Geodetic Observatory Wettzell), the geodetic part of the Commission for Geodesy and Glaciology (KEG), and the DGFI of the German Geodetic Commission cooperate within the Center of Geodetic Earth System Research[1] (CGE). IAPG and FESG are a part of Technische Universität München (TUM). KEG is a commission of BAdW, and DGFI is located at BAdW. CGE's main goal is the research of global change through the measurement of changes in the solid Earth, oceans, cryosphere, and atmosphere, as well as the analysis of changes with regard to the triggering physical processes. DGFI has been active as an Analysis Center (AC) of IVS since its foundation in 1999. For several years DGFI has been a reliable operational AC.

2. Staff

The DGFI IVS AC[2] is run by Robert Heinkelmann and Manuela Seitz. Julian Andres Mora-Diaz is working in a project for the establishment of space geodetic analysis software in Chile sponsored by the International Bureau of the Federal Ministry of Education and Research. In 2012, Mathis Bloßfeld started a promising and very interesting scientific comparison of the quality of various IVS networks and Michael Gerstl worked on the software developments and numerical optimizations of our VLBI analysis software DOGS-RI, which is about to be finished soon. Ralf Schmid (Figure 1) joined our VLBI group in July 2012. With his thorough background in space geodesy and his experience in GNSS and VLBI analysis and software development, Ralf is a great gain for DGFI's VLBI group. We are happy to have him on board. Robert Heinkelmann left DGFI to become the head of the VLBI group at GFZ, Potsdam. Manuela Seitz has been appointed as a member of the new IAU Division A Working Group on the 'Third Realization of the International Celestial Reference Frame'.

[1] http://dgfi.badw.de/index.php?id=323&L=0
[2] http://dgfi.badw.de/index.php?id=126&L=0

Figure 1. Our new colleague: Dr. Ralf Schmid.

3. Current Status and Activities

- IVS Operational Analysis Center at DGFI

  During 2012, we analyzed 404 sessions. Among them 265 were Intensive (IN112, IN212, and IN312), and 139 were regular observing sessions (73 IVS-R1 sessions, 52 IVS-R4 sessions, 10 astrometric type sessions, e.g. IVS-CRF, IVS-CRDS, etc., and four geodetic type sessions, e.g. IVS-T2). Several new telescopes became operational in 2012, and needed to be included in the software and catalog files. We thank the IVS colleagues, who provided initial a priori coordinates. For the operational analysis and for the preparation of normal equations in SINEX format OCCAM and DOGS-CS are used. CS is the module of the DGFI Orbit and Geodetic Parameter Estimation Software (DOGS) [1] for the handling and solution of normal equation systems. The entire process runs on DGFI-owned hardware.

- Rearrangement of the VLBI software used at DGFI

  The VLBI analysis software used at DGFI is currently being revised and will be a part of DOGS, named DOGS-RI (Radio Interferometry). In 2012, the inclusion of IERS 2010 conventional models was completed. In contrast to OCCAM, the theoretical VLBI model of DOGS-RI will directly refer to the Geocentric Celestial Reference System (GCRS) without application of the pole coordinates.

- Consistent computation of ITRF and ICRF from homogeneously processed observation data

  The main goal is the investigation of the effect of the combination of station coordinates and EOP of the space geodetic techniques (VLBI, GNSS, SLR) on the Celestial Reference Frame (CRF) [2]. In particular the combination of the ERP (terrestrial pole and LOD) has an impact on the CRF. The sources affected most are the sources observed by VLBA Calibrator Survey (VCS) sessions only. A systematic effect was found in right ascension for some of the VCS sources with declinations between $-40°$ and $+30°$ (see Figure 2). This work will be related to the new IAU Division A Working Group on the 'Third Realization of the International Celestial Reference Frame,' but it is on the IUGG agenda (Resolution 3 adopted in 2011) as well.

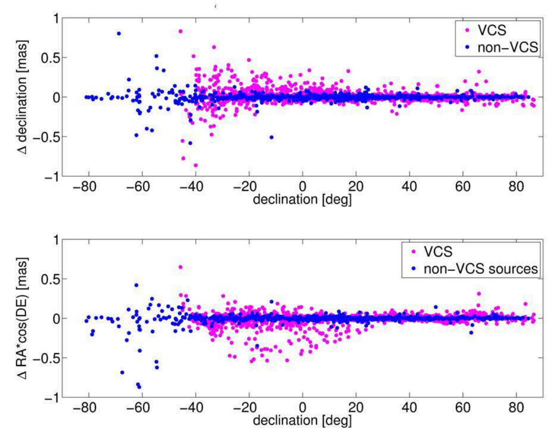

Figure 2. Position differences of radio sources of a TRF-CRF solution w.r.t. a VLBI-only CRF: (top) declination (DE), (bottom) right ascension (RA).

- The role of VLBI in the weekly inter-technique combination

  In the case of the standard ITRF computation, VLBI and SLR observations are used for the realization of the scale, and VLBI is the only technique which provides the full set of transformation parameters (terrestrial pole, UT1-UTC, celestial pole) necessary for transformations between the ITRS and the GCRS. Current terrestrial reference frames approximate the station coordinates by a position and a constant velocity after the well-known geophysical effects, e.g. tidal variations, have been reduced directly at the observation level. Other non-linear motions such as deformations caused by oceanic, atmospheric, and hydrologic mass loading deformations are still not sufficiently modeled and are thus not reduced at the observation level. This leads to larger observation residuals and introduces systematics, mainly seasonal signals, into the estimated parameters of the reference frame, e.g. if observations do not cover a complete season or are not evenly distributed within the seasonal cycle. In particular, this is the case for stations with short observation time spans. Besides the station coordinates, the neglected motions affect epoch-wise parameters as well, e.g. the EOP. To overcome this problem, reference frames can be based on much shorter time spans, e.g. by computing weekly reference frames. This approach is called epoch reference frame. In this case, non-linear station motions are approximated very well and, consequently, the EOP are not affected. An additional advantage of epoch reference frames is the significantly better timeliness after an episodic motion (earthquake or other seismic event, antenna repair, etc.), provided that the stations are still operating and a recent local tie measurement is available. Challenges within the epoch reference frame computation are the low average number of VLBI observations per week. The limited number of local tie measurements is a general problem for terrestrial reference frame determination; epoch reference frames are affected by the local ties even more. One week is practically the minimum supporting time base. Further studies will follow based on slightly longer time spans, e.g. two or four weeks. Based on those intervals we expect a significant increase in the stability of the solution but, of course, at the expense of a slightly worse approximation. The optimum interval length needs to be assessed. Probably it will comprise a trade-off between the stability and the quality of the approximation. Here, we investigate a sequence of epoch reference frames, all of which are determined by a combination of VLBI, GNSS, and SLR normal equations on a weekly basis [3]. For each VLBI session, the relative weighting of the techniques is achieved by estimating variance components (VC). Figure 3 shows the estimated VC for different types of IVS sessions between the beginning of 2000 and the end of 2006. The VC of the IVS-R1 sessions show a significant seasonal variation. The reasons for this seasonal variation are not completely understood.

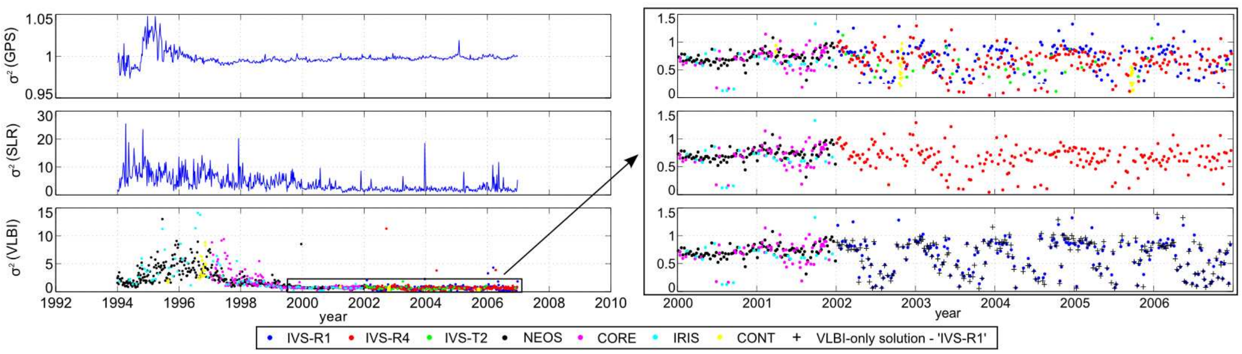

Figure 3. Left: posterior VCs of the techniques GPS (top), SLR (middle), and VLBI (bottom). In the case of VLBI, one VC per session is estimated. Right: zoom of the VLBI plot for 2000.0–2007.0. All VLBI sessions are shown for 2000 and 2001. Data shown for 2002.0–2007.0: all VLBI sessions (top), IVS-R4 sessions only (middle), and IVS-R1 sessions only (bottom). In addition, the lower right plot contains the posterior VCs of the VLBI-only solutions for the IVS-R1 sessions for comparison.

4. Future Plans

At the DGFI AC we will continue our operational contributions to IVS, but with our new VLBI analysis software DOGS-RI. After extensive comparisons we will switch to DOGS-RI, and the maintenance of OCCAM will cease. Investigations into the gain of CRF through an inter-technique combination and the quality of different types of IVS sessions will go on as well.

References

[1] Gerstl M., R. Kelm, H. Müller, W. Ehrnsperger: DGFI Orbit and Geodetic Parameter Estimation Software. Combination and Solution. Deutsches Geodätisches Forschungsinstitut, Interner Bericht Nr. MG/01/1995/DGFI, in German, 2000.

[2] Seitz M., P. Steigenberger, T. Artz: Consistent Realization of ITRS and ICRS. In: IVS 2012 General Meeting Proceedings, D. Behrend and K. D. Baver (eds.), NASA/CP-2012-217504 (2012).

[3] Bloßfeld M., M. Seitz: The role of VLBI in the weekly inter-technique combination. In: IVS 2012 General Meeting Proceedings, D. Behrend and K. D. Baver (eds.), NASA/CP-2012-217504 (2012).