

# BKG/DGFI Combination Center Annual Report 2014

Sabine Bachmann<sup>1</sup>, Linda Messerschmitt<sup>1</sup>, Ralf Schmid<sup>2</sup>, Mathis Bloßfeld<sup>2</sup>, Daniela Thaller<sup>1</sup>

**Abstract** This report summarizes the activities of the BKG/DGFI Combination Center in 2014 and outlines the planned activities for 2015. The main focus in 2014 was on the generation of the IVS contribution to the next ITRF, the inclusion of additional Analysis Centers into the combined solution, and the design and set-up of a new Combination Center website.

## 1 General Information

The BKG/DGFI Combination Center was established in October 2008 as a joint effort of the Federal Agency for Cartography and Geodesy (Bundesamt für Kartographie und Geodäsie, or BKG) and the German Geodetic Research Institute (Deutsches Geodätisches Forschungsinstitut, or DGFI). The participating institutions, as well as the tasks and the structure of the IVS Combination Center, are described in [1]. The tasks comprise quality control and a timely combination of the session-based intermediate results of the IVS Analysis Centers into a final combination product (e.g., Earth orientation parameters, or EOP). In coordination with the IVS Analysis Coordinator, the combination results are released as official IVS products. The Combination Center is also expected to contribute to the generation of the official IVS input to any ITRF activities.

1. Federal Agency for Cartography and Geodesy (BKG)

2. Technische Universität München, Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)

BKG/DGFI Combination Center

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The BKG/DGFI Combination Center performs a combination of session-based results of the IVS Analysis Centers on an operational basis. The strategy for the combination is based on the combination of normal equations and was adopted from the combination process as developed and performed by the IVS Analysis Coordinator (cf. [2], [3]). At BKG, the following tasks are performed:

- Quality control of the Analysis Center results: checking the format of the results and their suitability for combination, identification and reduction of outliers, comparison of the Analysis Centers' results with each other, and comparison of the results with external time series provided by the IERS or IGS.
- Feedback to the Analysis Centers: quality control results are available at the BKG IVS Combination Center web pages [5].
- Generation of high-quality combination products and timely archiving and distribution: combination products are created by using the combination part DOGS-CS of DGFI's software package DOGS (DGFI orbit and geodetic parameter estimation software) [4].
- Submission of official IVS combination products to the IERS: the products are submitted to the responsible IERS components to be used for IERS product generation (e.g., EOP rapid products and the EOP series IERS C04).
- Generation of the official IVS input to the ITRF: the combined session products (from 1984 to present) are submitted for ITRF computation in the form of normal equations in SINEX format. This work is also supported by the staff of the IERS Central Bureau, hosted by BKG.

- Final results are archived in the BKG Data Center and mirrored to the IVS Data Centers at Observatoire de Paris (OPAR) and Goddard Space Flight Center (GSFC). This work is assisted by the staff of the BKG Data Center in Leipzig.

DGFI is in charge of the following Combination Center functions:

- DGFI is developing state-of-the-art combination procedures. This work, as well as the following item, is related to the ITRS Combination Center at DGFI and DGFI's efforts within the IERS WG on Combination at the Observation Level (COL).
- The software DOGS-CS is updated by implementing and documenting the developed state-of-the-art combination procedures.
- Adhering to IERS Conventions: the DGFI DOGS software package is continuously updated to be in accordance with the IERS Conventions.

## 2 Activities during the Past Year

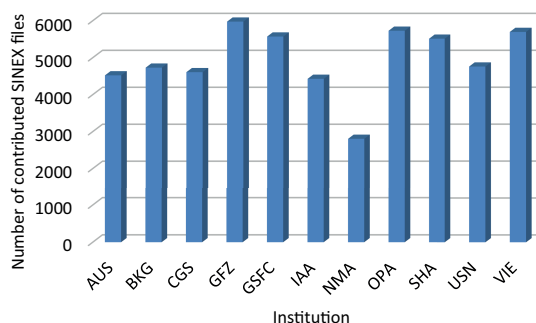
At BKG, the following activities were performed in 2014:

- Generation of a combined solution of IVS 24-h rapid sessions twice a week.
- Generation of a combined long-term solution of IVS 24-h sessions every three months.
- Validation and inclusion of 11 contributions to the IVS combined contribution to the ITRF.
- Ensuring that the combination process is in agreement with the IERS2010 Conventions.
- Generation of the IVS combined contribution to the next ITRF for the IERS ITRS Center.
- Inclusion of new Analysis Centers (GFZ, Germany and CGS, Italy) into the routine rapid combination.
- Design and set-up of the new IVS Combination Center website [5].
- Refinements of the combination procedure and implementation of source parameter combination.
- Development of an alternative combination procedure using the Bernese GNSS Software; implementation of the basic VLBI combination functions and preprocessing routines in cooperation with the University of Bonn.
- Participation in a pilot project on digital object identifiers (DOI) for data in cooperation with

R. Heinkelmann (Deutsches GeoForschungsZentrum, Germany); feasibility investigation for providing data and meta data.

An initial set of SINEX files for the ITRF generation was submitted to the IERS ITRS Center at the beginning of December 2014. Ten institutions had submitted their SINEX files in order to contribute to the combined solution. One of the main tasks in 2014 was to gather the SINEX contributions and to make sure that all contributions meet the IVS analysis specifications for ITRF contributions. In the course of the year, it turned out that the ITRF could be extended by another year, including sessions until the end of 2014 (instead of 2013 as foreseen in the original ITRF call for participation). With one year of additional data, an eleventh institution announced its participation. The challenge in 2014 was to ensure a consistent data quality, homogeneous data contributions, and the set-up of a combination procedure meeting the IVS specifications, e.g. meeting the IERS2010 standards.

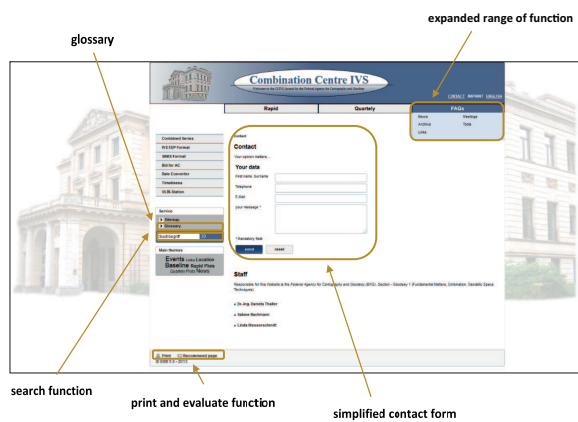
In Figure 1, the data contribution to the next ITRF is shown. Comparing the institutions contributing to the ITRF with those contributing to the routine combination listed in Section 4 illustrates the effort coming along with the ITRF contribution compared to the routine rapid combination. The final deadline for all IERS Technique Services for the (extended) ITRF contribution is now February 28, 2015.



**Fig. 1** AC SINEX files provided for the IVS combined solution for the next ITRF.

Within the past year, the IVS Combination Center website has been newly designed and set up [5]. The IVS Combination Center manages a stand-alone website to inform IVS users about VLBI combination de-

tails such as structure, basics, organization, and the current combination results. The content of these pages is regularly updated. To best use the technical progress we did some scale and structure changes. The basis is now a professional Content Management System (CMS), which was developed for this purpose. Many functions and extensions are already disposed in the CMS and will simplify the future administration. Now, users are able to fill in an evaluation form about the Web page content, to search for keywords, to look at glossary entries, or to print out all information. An automatic view of the recent combination status and many other tools were added. Due to these changes and the new design we will increase the benefit of the IVS. A screenshot of the newly designed Web site is shown in Figure 2. The new Web site is planned to go online within the first half of 2015.



**Fig. 2** Screenshot of the newly designed BKG Combination Center website.

At DGFI, the following activities were performed in 2014:

- Update of similarity transformation program.
- Handling of radio source position parameters with DOGS-CS.
- Validation of input files for ITRF contribution and evaluation of the weighting procedure within the combination in cooperation with BKG.

### 3 Staff

The list of the staff members of the BKG/DGFI Combination Center in 2014 is given in Table 1.

More details on the IVS Combination Center at BKG can be found in an interview for the IVS Newsletter [6].

### 4 Current Status

In 2014, six IVS Analysis Centers (BKG, DGFI, GSFC, IAA, OPA, and USNO) contributed to the IVS combined rapid and quarterly product (see [5]). The GFZ (German Research Center for Geosciences) and CGS (Centro di Geodesia Spaziale, Italy) Analysis Centers are currently under review and will become IVS Operational ACs in the near future. The rapid solutions contain only R1 and R4 sessions, and new data points are added twice a week as soon as the SINEX files of at least four IVS Analysis Centers are available. Long-term series are generated quarterly and include all 24-h sessions since 1984. The quarterly series include long-term EOP, station positions, and velocities. Furthermore, a VLBI TRF is generated and published. The preprocessing to read and write source positions was implemented, and the software was extended to process source parameters. The results of the combination process are archived by the BKG Data Center in Leipzig. The combined rapid EOP series, as well as the results of the quality control of the Analysis Center results, are also available directly at the BKG/DGFI Combination Center website [5] or via the IVS Analysis Coordinator website.

### 5 Future Plans

In 2015, the work of the BKG/DGFI Combination Center will focus on the following aspects:

- Finishing the extended IVS contribution to the next ITRF realization: inclusion of the IVS sessions of one additional year (2014).
- Inclusion of new Analysis Centers (CGS and GFZ) into the routine rapid and quarterly combination.

**Table 1** Staff members of the BKG/DGFI Combination Center.

Name	Affiliation	Function	E-Mail
Sabine Bachmann	BKG	Combination procedure development	sabine.bachmann@bkg.bund.de
Linda Messerschmitt	BKG	Operational combination /Web site maintenance	linda.messerschmitt@bkg.bund.de
Mathis Bloßfeld	DGFI	Combination strategies	mathis.blossfeld@tum.de
Michael Gerstl	DGFI	Software maintenance	michael.gerstl@tum.de
Ralf Schmid	DGFI	Combination strategies	schmid@tum.de

- Investigation of the combination of source coordinates for time series of source coordinates and generation of a combined celestial reference frame based on VLBI intra-technique combination.
- Establishing the digital object identifier (DOI) for combined VLBI products in cooperation with GFZ.

## References

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2. Nothnagel, A., Böckmann, S., Artz, T., *Analysis Coordinator Report*, in: *International VLBI Service for Geodesy and Astrometry 2007 Annual Report*, NASA/TP-2008-214162, D. Behrend and K. D. Baver (eds.), 16-17, 2008.
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4. [http://ilrs.dgfi.badw.de/fileadmin/dogs/cs\\_manual.ps](http://ilrs.dgfi.badw.de/fileadmin/dogs/cs_manual.ps)  
DOGS-CS software manual (German version only).
5. <http://ccivs.bkg.bund.de/> BKG Combination Center website.
6. Hase, H., BKG/DGFI Combination Center at Frankfurt, IVS Newsletter 36, 2-3, 2013. <http://ivscc.gsfc.nasa.gov/publications/newsletter/issue36.pdf>.