

BKG/DGFI Combination Center Annual Report 2010

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Abstract

This report summarizes the activities of the BKG/DGFI Combination Center in 2010 and outlines the planned activities for the year 2011. The main goal in 2010 was to perform the operational combination of the IVS Rapid EOP series (R1 and R4 sessions). Since October 1, 2009 these combinations have been performed at the BKG/DGFI Combination Center. In 2011 the responsibility for the operation of the IVS quarterly solutions should also be taken over from the IVS Analysis Coordinator.

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, BKG) and the German Geodetic Research Institute (Deutsches Geodätisches Forschungsinstitut, DGFI). The participating institutions, as well as the tasks and the structure of the IVS Combination Center, have been described in [5]. 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 (EOP)). In coordination with the IVS Analysis Coordinator, the combination results will be 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. These tasks should be performed on an operational basis.

2. Component Description

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 has been adopted from the combination process developed and performed by the IVS Analysis Coordinator (cf. [3], [4]). In 2009 the responsibility for the combination of the two IVS EOP series (rapid and quarterly solutions) on the basis of datum-free normal equations in SINEX format was taken over by the Combination Center.

At BKG Combination Center (BKG CC) the following tasks are performed:

- Ensuring quality control of the Analysis Center results: Checking the format of the results and their suitability for combination, performing identification and reduction of outliers, comparing the Analysis Centers' results with each other, and comparing the results w.r.t. external time series, e.g. from IERS or IGS.
- Providing feedback to the Analysis Centers: Quality control results will be available at the BKG/DGFI IVS Combination Center Web page [6]. If requested by the Analysis Centers, the results will be provided by e-mail, too.
- Creating high quality combination products and performing timely archiving and distribution: Combination products will be created using the DGFI DOGS software package [7].
- Submitting official IVS combination products to the IERS: The produced official IVS combination products will be submitted to the responsible IERS components as requested by the IERS. This will be supported by the staff of the IERS Central Bureau at BKG.

- Placing final results in IVS Data Centers: Final results will be placed in the BKG Data Center. This will be assisted by the staff of the BKG Data Center in Leipzig.
- Generating official IVS input to the ITRF: Official IVS input to the ITRF will be created as combined weekly solutions in SINEX format.

DGFI is in charge of the following Combination Center functions:

- Developing state-of-the-art combination procedures: State-of-the-art combination procedures will be developed mainly at DGFI. This work, as well as the following item, is also related to DGFI's efforts within the IERS WG on the Combination on Observation Level (COL).
- Performing software development and documentation: At DGFI the DOGS software package will be continuously updated by implementing 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.

3. Staff

At the end of March 2010 Wolfgang Schwegmann, responsible for the BKG CC, left BKG and thus the Combination Center after several years of collaboration with the IVS. At BKG, without interruption, Sabine Bachmann took over the combination procedure. The list of the staff members of the BKG/DGFI Combination Center in 2010 is given in Table 1.

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

Name	Affiliation	Function	E-Mail
Michael Gerstl	DGFI	Software maintenance	gerstl@dgfi.badw.de
Robert Heinkelmann	DGFI	Combination strategies	heinkelmann@dgfi.badw.de
Sabine Bachmann	BKG	Combination	sabine.bachmann@bkg.bund.de
Alexander Lothhammer	BKG	Hardware maintenance	alexander.lothhammer@bkg.bund.de

4. Current Status and Activities

The combination of the IVS Rapid EOP series (R1 and R4 sessions), started in 2009 at BKG, has been continued routinely in 2010. In 2010, six IVS Analysis Centers (BKG, DGFI, GSFC, IAA, OPA, and USNO) contributed to the IVS combined product (see [4]). 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. The results of the combination process are placed in 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 at the BKG/DGFI

Combination Center Web page [6]. The main update of the combination procedure was the change of the nutation parameter from $d\psi$ and $d\epsilon$ (referring to the IAU2000A precession-nutation model) to dX and dY (referring to the IAU2006 precession-nutation model), the latter being used by four out of the six Analysis Centers.

The completion of the IVS quarterly solution has been intensively continued. Within the quarterly combination, every three months all available sessions from 1979 up to the present are combined. Presently several tests have been performed with good intra-technique results. Comparisons with external time series from IERS and IGS are under way.

5. Plans for 2011

The inter-technique combinations for IVS activities are currently performed by accumulating either normal equations or solution equations. Since the observations analyzed by the various Analysis Centers are initially identical, combinations on the observation equation level are pointless. Compared to the combination of solution equations, the normal equation level is advantageous because it still enables correlations among the parameters and allows the addition of a unique set of datum (condition) equations. The functional models of the inter-technique combination methods for normal equations and solutions are trivial, while the stochastic models are not. The current algorithm applied for routine combinations on the normal equation level includes individual scaling of the Analysis Centers' contributions through variance component estimation. The scaling is in particular valuable, because different parameter estimation techniques (e.g. least-squares adjustment, Kalman filter, Square Root Information Filter (SRIF), or least squares collocation) may be applied. Besides the scaling among the Analysis Centers the combination algorithm should consider the fact that the same original observations are used by the Analysis Centers. The 're-application of observations' requires the stochastic model to contain off-diagonal elements. The framework of a combination theory considering this fact was introduced by [2] and labeled the Operator Software Impact (OSI). As a first step for improving the IVS combination strategy, the OSI model has been applied to the combination of troposphere parameters during CONT08 [1]. In 2011 it is planned to test the OSI model on the normal equation level and to make it available for IVS routine combinations.

In 2011 the work of the BKG/DGFI Combination Center will focus on the following:

- Performing the IVS quarterly solution combination on an operational basis.
- Performing quality control of improved Analysis Center solutions and using these solutions in the routine combination.
- Including two new Analysis Center solutions: one based on the GEOSAT software and provided by Halfdan Pascal Kierulf from the Geodetic Institute, Norwegian Mapping Authority (NMA), Hønefoss, Norway, and the other based on the OCCAM software and provided by Oleg Titov from Geoscience Australia (AUS), Canberra, Australia.
- Entire transition of the combination software to the actual nutation parameter dX and dY as soon as every AC contributes these parameters in their SINEX files.
- Extending the combination analysis by including source parameters.

- Maintaining and extending available information on the combination procedure and combination results available at the Combination Center Web page [6].

References

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- [6] <http://vlbi.geod.uni-bonn.de/IVS-AC/index.html>
BKG/DGFI Combination Center results at Analysis Coordinator's Web page.
- [7] http://ilrs.dgfi.badw.de/fileadmin/dogs/cs_manual.ps
DOGS_CS software manual (German version only).