DGFI Analysis Center Annual Report 2003

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Abstract

This report summarizes the activities of the DGFI Analysis Center in 2003 and outlines the planned activities for the year 2004.

1. DGFI Analysis Center Operation

The German Geodetic Research Institute (Deutsches Geodätisches Forschungsinstitut, DGFI) is an autonomous and independent research institution located in Munich. It is supervised by the German Geodetic Commission (Deutsche Geodätische Kommission, DGK) at the Bavarian Academy of Sciences. The research covers all fields of geodesy and includes the participation in national and international research projects as well as functions in international bodies.

The long-term research programme of DGFI is based on the general theme "Fundamentals of Geodetic Reference Systems". The definition of geodetic reference systems is studied and methods for their realisation with modern space geodetic techniques are developed. Geodetic observations are analysed, approaches for the data processing are set up, tested and exemplarily applied (see DGFI web server `http://www.dgfi.badw.de`).

DGFI contributes to the International VLBI Service (IVS) as an Analysis Center to improve the space-geodetic observation technique Very Long Baseline Interferometry (VLBI) and the analysis of its observations, respectively, by participating in pilot projects and by research projects which are mainly concerned with the modelling of VLBI observations.

2. Activities in 2003

1. Refinement of the stochastic model of VLBI observations

   Up to now, improvements of modelling the observations of "Very Long Baseline Interferometry (VLBI)" are mainly achieved by refining the functional representation of the geometrical-physical properties of the observations. Further progress in this field requires big efforts and is not possible with any precision. In contrast, the stochastic properties of the observations (which comprise functionally not representable influences) have not been handled thoroughly.

   The refinement of the stochastic VLBI model considered here is based on two principal ideas: (1) Discrepancies between the functional model and the observations can be understood at least approximately as variances of the observations. (2) Deficits of the functional model which affect several observations more or less systematically might be interpreted as covariances (correlations) between observations. For this reason, the deficits of the stochastic model of VLBI observations were studied in order to set up a more adequate structure of the variance-covariance matrix of the observations. The associated unknown variance and covariance components were estimated according to the MINQUE principle.

   The most significant improvements of the conventional stochastic VLBI model were found to be related to the observing stations (site-specific effects) and the elevation angles (tropospheric effects) (see Tesmer, 2003). Although standard VLBI solutions can be improved by the refined stochastic model for the observations, its potential is not yet exhausted.

2. Parameter constraints in VLBI data analysis

   It is common practice in VLBI parameter estimation to model two types of parameters. On the one hand there are classical target parameters such as station coordinates and Earth orientation parameters. On the other hand there are additional parameters like, e.g., the coefficients of the piecewise linear functions for the troposphere and the clocks as well as the offsets of the horizontal tropospheric gradients per station. In order to stabilize the estimation, prior information on the additional parameters is added by means of pseudo-observations (soft constraints). For assessing the impact of these constraints on the VLBI results, several aspects were studied such as the bias of the parameters, the respective contribution of the constraints to the estimation, and the consistency of observed data and prior information. Numerical results were derived from the NEOS-A sessions of 2000 and 2001 using the VLBI software OCCAM 5.0 (Least Squares Method).

   Typically, the induced parameter bias is visible in the results but it is not significant. However, in sessions with extended gaps of observation data the results can be strongly influenced. The contribution of the constraints to the estimated parameters (in terms of partial redundancies calculated for the constraints) is rather moderate in the standard case but becomes dominant in case of increased weights, in particular for the gradient offsets. This is underlined by results for the statistical consistency of the constraints and the observed data. Particular care must be taken in case of weakly configured networks, which can be due to temporary losses of observations on single VLBI sites. For details see Kutterer (2003).

3. CONT02 VLBI normal equations for a rigorous combination with GPS

   From 16th to 31st of October 2002, the CONT02 VLBI observation campaign, which was initiated by the IVS, was carried out. This campaign is especially suitable for the combination of VLBI observations with those of other space-geodetic techniques.

   In order to provide the optimum conditions for combining VLBI and GPS as rigorously as possible, much care was taken to set up VLBI normal equations with models and estimated parameters which are adapted to those of the used GPS normal equations. The following models or parameter representations had to be verified or modified, respectively, in the VLBI software OCCAM: solid Earth tides, pole tide, ocean loading, tropospheric delay, subdaily EOP variations, daily a-priori EOP values and their interpolation as well as the nutation model. The VLBI observation data were additionally reformatted from 24h blocks, beginning at 18 h UTC to blocks beginning at 0 h UTC in order to avoid a potential error source. The normal equations were supplied in the SINEX 1.0 format. First CONT02 combination results of VLBI and GPS data are for example reported in Thaller et al. (2003).

4. IVS OCCAM working group

   The software OCCAM which is used at DGFI to analyse VLBI observations is continually improved by a group of scientists from Geoscience Australia (Canberra, Australia), the Vienna University of Technology (Vienna, Austria), the St. Petersburg University, the Institute of Applied Astronomy (both St. Petersburg, Russia) and DGFI. As the groups concentrate on different research fields, an official version (currently 6.0) of the source code is kept which reflects the common interest. This version is updated if needed. The group met twice on the occasion of international scientific meetings (4th IVS Analysis meeting in Paris, France; Les Journées 2003, St. Petersburg, Russia) in order to define and to partially elaborate the source code changes. DGFI's most important contributions to the new version of OCCAM are an advanced outlier rejection routine (Kutterer et al., 2003) and a first version of a refined stochastic model for VLBI observations (see Tesmer, 2003). There is also a new interface for the conversion of OCCAM internal normal equations into a DOGS-CS readable format.

3. Staff

The personnel of DGFI involved in the IVS Analysis Center during 2003 did not change w.r.t. 2002, notably Hermann Drewes, Hansjörg Kutterer and Volker Tesmer. Volker Tesmer was funded externally by the German research association 'Deutsche Forschungsgemeinschaft (DFG)' under the contract DR 143/11-1.

4. Plans for 2004

The primary contributions will be to participate in further Pilot Projects of IVS. Additionally, DGFI will take part in the IVS VLBI2010 Working Group. In the medium term, DGFI aims to become an operational IVS Analysis Center, which would imply a commitment to regularly contribute to the official IVS products. Other research goals will be:

- Further improvement of the VLBI software OCCAM
- Simultaneous and consistent determination of a TRF, a CRF and the EOP in one solution using minimum datum constraints
- Combined estimation and comparative analysis of geodetic target parameters from VLBI and GPS observations

5. References

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