The DGFI realization of the International Terrestrial Reference System: the DTRF2008

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1. Introduction

A new realization of the International Terrestrial Reference System (ITRS) was computed at the ITRS Combination Centre at DGFI and provided to the IERS in 2010. The solution was computed in the framework of the ITRF2008 (Altamimi et al. 2011). It is labeled DTRF2008. The solution is based on the same input data as the ITRF2008: time series of normal equations or solutions derived from the analysis of the space geodetic techniques VLBI, SLR, GPS and DORIS, which are provided by the respective IAG services. The parameter space of DTRF2008 comprises station positions and velocities, and daily resolved Earth Orientation Parameters (EOP), whereby for the first time also the nutation parameters are included (Seitz et al., 2012a).

The computation strategy applied at DGFI is based on the combination of normal equation systems while the IGN solution, the ITRF2008, is computed from a combination of solutions. Due to the differences in the computation strategies the two solutions are in some way independent. The availability of two solutions provides the possibility to assess the accuracy of today ITRS realizations by inter-comparisons.

This document gives a summarizing description of the DTRF2008. The solution is explained in detail by Seitz et al. 2012a. Additional information about the comparison of DTRF2008 and ITRF2008 and the accuracy assessment of the ITRS realizations is given by Seitz et al. 2012b. The DTRF2008 solution is available at the DGFI website (http://www.dgfi.badw.de/index.php?id=258) and the
DGFI ftp server (ftp://www.dgfi.badw.de/pub/DTRF2008/).

2. Computation strategy

The general concept of the computation strategy is based on the combination of constraint-free (in the sense of datum parameters) normal equations. This combination approach is a very good approximation of the combination on the observation level if the analysis of the technique observations are performed using the same models and parameterization. The combination is performed with the software DOGS-CS, the combination part of the DOGS software (DGFI Orbit and Geodetic Parameter Estimation Software) (Gerstl et al., 2001). Figure 1 shows the simplified flowchart of the combination procedure.

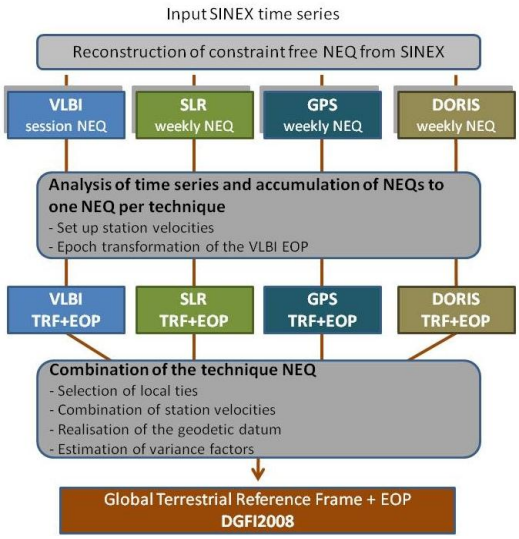

Figure 1: Simplified flowchart of the DGFI computation strategy applied for DTRF2008.

In a first step the input normal equation time series are analyzed by solving each normal equation. The analysis of the time series of the station positions, datum parameter and EOP is performed in order to identify discontinuities in the time series which have to be considered in the DTRF2008 and to see whether the datum

information provided by the techniques (origin: SLR, scale: SLR and VLBI) is stable to be used to determine the DTRF2008 datum. The analysis provided that the mentioned datum information was suitable to be used in DTRF2008. Finally, the normal equation time series are combined to one NEQ per technique by setting up the station velocities as new parameters.
In a second step the different technique NEQ are combined by introducing local tie measurements (collected and prepared by Z. Altamimi, IGN) as additional observations. The identification of local ties which should be introduced as well as their standard deviations was performed by homogenizing the two criteria (1) the network deformation due to the combination shall be minimal (2) the consistency of the combined frame shall be as high as possible. A measure for the last criteria is the offset between consistently estimated but still uncombined EOP series (see Seitz et al., 2012a). Furthermore, velocities of co-locating stations are combined by introducing pseudo-observations of the form v1-v2=0, using a standard deviation of 0.1 mm/yr. The datum of the DTRF2008 is realized as follows: the origin and its linear change in time are realized from all SLR observations, the scale and its rate are realized by VLBI and SLR observations (no significant difference between the two technique scales was detected) and the orientation is realized by no-net-rotation conditions (for positions and velocities) with respect to ITRF2005.
The relative weighting of the techniques is computed by relating the estimated standard deviations of the station coordinates to the precision values of a mean position and a velocity derived from station position time series analysis. The results lead to a down-weighting of GPS by a factor of 0.34, which can be related to the non-considered correlations between the GPS observations.

3. Accuracy assessment

In order to assess the accuracy of DTRF2008 internal validations and external comparisons with ITRF2008 and ITRF2005 are performed.

3.1 Internal accuracy

The internal accuracy of DTRF2008 was derived from the comparison of DTRF2008 with the technique-specific multi-year solutions. An internal accuracy between 0.32 mm for VLBI and 3.3 mm for DORIS was found for positions. The range for the velocities is from 0.05 mm/yr for VLBI to 0.83 mm/yr for DORIS. The values reflect the mean deformation of the technique networks due to the combination. The internal consistency of the combined frame derived from the analysis of the pole coordinates is 1.5 to 2.5 mm for GPS, VLBI and SLR and 6.5 mm for DORIS.

3.2 External accuracy derived from a comparison of DTRF2008 and ITRF2008 and ITRF2005, respectively

The external accuracy of the ITRS realizations was derived from inter-comparisons. They provide an agreement with respect to the datum parameters of 2-5 mm and 0.1-0.8 mm/yr depending on the technique. The network geometries (datum independent part) agree within 3.2 mm for positions and 1.0 mm/yr for velocities. A comparison of DTRF2008 and ITRF2005 provides similar results for the datum parameters but larger differences for the network geometries: 2-6 mm and 0.3 -1.6 mm/yr, which can be explained by the changes in the reduction models between ITRF2005 and DTRF2008.
Looking at the EOP, the pole coordinates of DTRF2008 and ITRF2008 agree well (WRMS: 0.06 and 0.177 mas for x- and y-pole, respectively). For the time span when GPS contributes, the noise of the DTRF2008 time series with respect to IERS 05 C04 is a bit larger due to the above mentioned down-weighting of GPS. The comparison of UT1-UTC provides a mean offset of 0.01 ms (~ 4.6 mm at the Earth's surface), which corresponds to differences in the orientation of the VLBI parts of the networks. The comparison of LOD also with IERS 05 C04 shows some signature in the ITRF2008 series shown in Seitz et al., 2012a, which should be further studied.

4. Summary

The paper gives a short description of the ITRS realization, DTRF2008, computed at DGFI. A detailed description of the solution is given by Seitz et al., 2012a. The accuracy of the ITRS realizations assessed from comparisons of DTRF2008 and ITRF2008 and ITRF2005, respectively, is given by Seitz et al., 2012a and Seitz et al., 2012b. Based on the experiences of DTRF2008, the chapter 9 of Seitz et al., 2012a "Discussion and Conclusions" provides a list of recommendations for further ITRS realizations.

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Acknowledgments:

The Deutsches Geodätisches Forschungsinstitut (DGFI) hosts and funds one of the ITRS Combination Centres. We thank the Analysis and Combination Centres of the IAG Services IGS, IVS, ILRS and IDS for their contributions to ITRF2008, for their great effort of performing the re-processing of the complete observation data series with the latest models and for the productive discussions and the very kind assistance in case of questions. We especially thank the ITRS Centre at Institut Géographique National (IGN), namely Zuheir Altamimi, for organizing the ITRF computation and for the collection and provision of the input data. It was the basis for the processing of the ITRF. We kindly thank the ITRS Combination Centre at IGN for the good cooperation and the fruitful discussions.