FFI Technology Development Center - Software Development

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Abstract

FFI's contribution to the IVS as a Technology Development Center will focus primarily on the development and validation of the GEOSAT software for a combined analysis at the observation level of data from VLBI, GPS and SLR. This report shortly summarises the latest improvements of the GEOSAT software. FFI is currently Analysis Center for IVS and ILRS, Technology Development Center for IVS, and Combination Research Center for IERS.

1. The GEOSAT Software

The advantages of the combination of independent and complementary space geodetic data at the observation level is discussed in Andersen ([1]). The models of GEOSAT are listed in Andersen ([2]). The most important changes implemented in 2004 are described in the following.

A new major software component of GEOSAT has been developed for 3D raytracing through the atmosphere. A complete 3D atmospheric model provided daily by ECMWF is input to the software. Based on the available tracking (VLBI, GPS, or SLR) for that specific date a set of tables for each active station is automatically generated with information about the time delay in the different elevation and azimuth directions. Also statistical information concerning the variability of relevant parameters are extracted from the ECMWF data. This information is used in the estimation filter as time-dependent parameter constraints. No mapping functions are used anymore. A new model/parameterization for the atmospheric delay is under extensive testing in GEOSAT. The status is that ten years of VLBI-only sessions have been analyzed. A clear reduction in a posteriori residuals is observed. The Grueger model is default for the MW refractive index and the Ciddor model is default for the optical or near optical wavelengths. The Ciddor model has been tested against Ciddor's own software.

The pressure loading tables provided by Leonid Petrov are used by GEOSAT. For stations not included in this table a simple pressure scaling model is used where the load scale parameter is automatically estimated in the analysis. A grid of reference pressure values has been derived by averaging the surface pressure levels provided by NCEP during the last 20 years.

A model for thermal deformation of the VLBI antenna construction has been included. Thermal coefficients and thermal time delays can be estimated. Empirical VLBI axis offsets distributed by Axel Nothnagel recently, has been implemented in GEOSAT and are used as a priori values for the axis offsets.

Station-dependent center-of-mass corrections for the two Lageos satellites have been implemented according to recommendations of the ILRS signal processing working group. An ocean tide gravity model derived from Topex data has been implemented in GEOSAT.

The station eccentricity file has been checked in great detail and updated with all the most current log files of VLBI, GPS, and SLR. The eccentricity information is treated as a new observation type in GEOSAT in addition to the VLBI, GPS, and SLR observation types.

The GEOSAT software calculates one set of station coordinates and velocities for a reference marker at a colocated station in addition to the eccentricity vector to each different antenna reference point. The software has been extended so that observations from several active VLBI

systems, GPS receivers and SLR systems will all contribute to the estimation of the parameters for the station reference marker. The instruments could be operating either simultaneously or in different time windows.

The IERS 2004 Conventions have been fully implemented including the new EOP parameterization. The new subroutines have been extensively tested.

The absolute GPS satellite antenna phase center table published by Rothacher recently has been implemented as an a priori model. The parameters will be estimated during the analysis.

All relevant partial derivatives have been verified against numerical partial derivatives.

In the global processing of several years of data the stable sources listed by Feissel et al. are automatically estimated as constants while the others are estimated as random walk parameters or session parameters. A set of defining stations satisfying certain criteria is automatically estimated as constants where the other stations are estimated as constants during a certain interval (between one day and one month).

The GEOSAT software has been extended for analysis of tracking data from spacecrafts in the Solar systems. Only minor problems remain before the software can be used for such applications.

2. Future Plans

We plan to implement an orbital overlap scheme for automatic evaluation of the orbit quality (GPS, LAGEOS). Observations from the GALILEO navigation system will be applied when available. Only minor changes in GEOSAT are required for this extension.

3. Staff

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References

[1] Andersen, P. H. Multi-level arc combination with stochastic parameters. Journal of Geodesy (2000) 74: 531-551.

[2] Andersen, P. H. High-precision station positioning and satellite orbit determination. PhD Thesis, NDRE/Publication 95/01094.