FFI Analysis Center

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Abstract

FFI's contribution to the IVS as an analysis center will focus primarily on a combined analysis at the observation level of data from VLBI, GPS and SLR using the GEOSAT software. This report shortly summarises the current status of analyses performed with the GEOSAT software. FFI is currently Analysis Center for IVS and ILRS, Technology Development Center for IVS, and Combination Research Center for IERS.

1. Introduction

Recently, a number of colocated stations with more than one observation technique have been established. In principle, all instruments at a given colocated station move with the same velocity and it should be possible to determine one set of coordinates and velocities for each colocated site. In addition, a constant eccentricity vector from the reference point of the colocated station to each of the individual phase center of the colocated antennas is estimated using constraints in accordance with a priori information given by the ground surveys. One set of Earth orientation parameters (EOP) and geocenter coordinates can be estimated from all involved data types. The present dominating error source of VLBI is the water content of the atmosphere which must be estimated. The introduction of GPS data with a common VLBI and GPS parameterization of the zenith wet delay and atmospheric gradients will strengthen the solution for the atmospheric parameters. The inclusion of SLR data, which is independent of water vapour, give new information which will help in the de-correlation of atmospheric and other solve-for parameters and lead to more accurate parameter estimates. These, and many more advantages with the combination of independent and complementary space geodetic data at the observation level, are fully accounted for with the GEOSAT software ([2]) developed by FFI during the last 17 years.

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3. Combination of VLBI, GPS, and SLR observations at the observation level

A set of VLBI data from January 1993 to December 2002 is being analyzed. This analysis will be referred to as the VLBI-alone analysis. A second analysis (referred to as the combined analysis) is being performed where SLR data for Lageos I and Lageos II from the same period are combined with the VLBI data at the observation level using exactly the same strategy as for the VLBI-alone analysis. In addition approximately 300 days of GPS data are included in the combined analysis. The two analyses are performed in arcs of 24 hours using the GEOSAT software. The arc-results are combined into a multi-year VLBI-alone and a combined VLBI, GPS and SLR solution using the CSRIFS software ([1]) which is a part of the GEOSAT software.

The following parameters are among the parameters simultaneously estimated in the combined

analysis:

- Station coordinates, eccentricity vectors, and station velocities

- Earth orientation parameters

- Radio source coordinates and satellite orbits (GPS and the Lageos satellites) including some satellite-dependent dynamical parameters

- Geocenter position relative to the terrestrial polyhedron realized by the stations

- Spherical harmonic coefficients to account for Earth's surface mass redistribution ([4])

- C21 and S21 gravity coefficients to make polar motion estimates from VLBI and satellite tracking data consistent

- VLBI antenna axis offsets

- SLR range bias for selected stations

- Combined VLBI and GPS tropospheric zenith delays and gradients for colocated stations

- Relative VLBI/GPS tropospheric zenith offsets to account for the height difference between the two antennas

- GPS satellite antenna phase center z-offsets and nadir variations with one set of estimates for each of the satellite types (Block I, Block IIA, and Block IIR)

The results from the analyses will be presented at the EGS meeting in Nice in April, 2003, and at the IUGG meeting in Sapporo in July, 2003.

Bĺrd-Henning Tvedt performed as part of his MSc-thesis (under the supervision of P. H. Andersen), a number of VLBI analyses ([3]). He investigated the problems and possible advantages of combining individual VLBI sessions taken on the same day into one daily session. There are a few complications that can be handled and the results show that the improvement is marginal in most cases, although the results for sessions with a small number of participating stations improve. He also investigated the consistency between the ITRF-2000 and the IERS(EOP)C04 series from a comparison with his results and discussed the problems involved in such a comparison.

4. Future plans

The FFI project covering IERS, IVS, ILRS, and IGS related activities has been approved until the end of 2005. The GEOSAT software has recently been converted to PC/LINUX. The computation time per combined VLBI/GPS/SLR session has been reduced from 16 hours to 6-7 hours going from a HP J7000/UNIX computer to a 2.8 GHz PC/LINUX computer. We plan to set up a network of 5 to 20 PCs over the next three years to process combined VLBI/GPS/SLR sessions. With such a computation power it should be possible to process daily GPS/SLR or VLBI/GPS/SLR sessions in addition to frequent recalculation of historical data for research purposes. Some years ago the idea was to demonstrate and investigate the problems and possible advantages with a combined analysis of VLBI, GPS and SLR observations. With the new increased computation power we are going from a demonstration phase towards a production phase where it is realistic to process on routine basis observations from a large network of VLBI, GPS and SLR stations.

References

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[3] Tvedt, B.-H. Analysis of Space-Geodetic VLBI Observations with different Analysis Strategies. MSc Thesis, Institute of Theoretical Astrophysics, University of Oslo, May 2002.

[4] Blewitt, G., Clarke, P. Inversion of Earth's Changing Shape to Weigh Sea Level in Static Equilibrium with Surface Mass Redistribution. Manuscript submitted to JGR, 4 Nov. 2002.