3.6.2.4 Forsvarets forskningsinstitutt (FFI)

Introduction

FFI has during the last 20 years developed a software package called GEOSAT (Andersen, 1995) for the combined analysis of VLBI, GPS, SLR and other types of satellite tracking data (GLONASS, DORIS, PRARE and altimetry). The observations are combined at the observation level with a consistent model and consistent analysis strategies. The data processing is automated except for some manual editing of the SLR observations.

In the combined analysis of VLBI, GPS and SLR observations the data are processed in arcs of 24 hours defined by the duration of the VLBI session. The result of each analysed arc is a state vector of estimated parameter corrections and a Square Root Information Filter array (SRIF) containing parameter variances and correlations. The individual arc results are combined into a multiyear global solution using a Combined Square Root Information Filter and Smoother program called CSRIFS. With the CSRIFS program any parameter can either be treated as a constant or a stochastic parameter between the arcs. The estimation of multiday stochastic parameters is possible and extensively used in the analyses. The advantages of the combination of independent and complementary space geodetic data at the observation level is discussed in (Andersen, 2000).

Status

The GEOSAT software has during 2004 undergone extensive changes and improvements. This work will continue through 2005.

The most important changes implemented in 2004 are described in the following. The GEOSAT software has recently been upgraded to use numerical weather models (ECMWF) and 3D ray tracing for the calculation of signal delays due to the troposphere. Ten years of VLBI data have been analysed with this feature and the improvement of the results is remarkable. A lot of experimentation must be performed before final conclusions can be drawn, but it seems that the ECMWF model needs to be scaled by one or more estimated parameters in the VLBI analyses. Plots of these estimates and spectral analyses of the results reveal interesting results. The general trend is that the ECMWF model seems to perform better at low latitudes than at higher latitudes. There is a clear seasonal signal especially for the higher latitudes. The noise level of the estimated Earth orientation parameters is typically at the level of 50 microarcseconds for the angles and 2-3 microtimeseconds for UT1. The results suggest that the applied procedure can be used to investigate how well the ECMWF model is able to describe climatic changes. Of cause, many more years of data must be analysed for such applications.

Some months of SLR Lageos 1&2 data have been analysed with promising results.

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

Station-dependent centre-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 IERS 2004 Conventions, including the new EOP parameterisation, has been fully implemented and tested.

The GEOSAT software has been extended for analysis of tracking data from spacecrafts in the Solar systems.

Future plans

Observations from the GALILEO navigation system will be applied when available. Only minor changes in GEOSAT are required for this extension.

References

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

Andersen, P. H. (1995) High-precision station positioning and satellite orbit determination. PhD Thesis, NDRE/Publication 95/01094.

Per Helge Andersen