

# FFI Technical Development Center - Software development

*Per Helge Andersen*

## Abstract

FFI's contribution to the IVS as a Technical 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]). Recent changes are described in the following.

It is a fact that the position of the effective phase center of the transmitter antenna of the GPS satellites is not very well known. This leads to a scale inconsistency with VLBI and SLR of 2-14 ppb depending on the model used for the phase center variation of the GPS receiver antenna. The possibility of estimating 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), has been implemented in GEOSAT. Since the GPS data in our case are combined with VLBI and SLR data absolute positions of the phase center of all satellites can be determined. Since the estimate of the GPS transmitter antenna phase center depends on the models used for the correction of the receiver antenna phase center variations, absolute models for the latter have been incorporated in the GEOSAT software. The GPS station log files used by GEOSAT have been revised.

Spherical harmonic coefficients to account for Earth's surface mass redistribution (Blewitt and Clarke [3]) can also be estimated with the newest version of GEOSAT.

Other recent improvements in GEOSAT include:

- Inclusion of GLONASS analysis and combined VLBI/GPS/GLONASS/SLR analysis. This was done as a preparation for a combined VLBI/GPS/GALILEO/SLR analysis.
- Automatic editing of poor GPS satellites.
- Improved GEOSAT robustness with automated combined VLBI/GPS/SLR analysis. Only a few percent of runs are aborted mostly due to badly formatted GPS data or multiple severe VLBI clock jumps.

## 2. 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.

### 3. Staff

Dr. Per Helge Andersen - Research Professor of Forsvarets forskningsinstitutt (FFI) and Institute of Theoretical Astrophysics, University of Oslo.

### 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.
- [3] 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.