NMA Analysis Center

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Abstract

The Norwegian Mapping Authority (NMA) has during the last few years had a close cooperation with Norwegian Defence Research Establishment (FFI) in the analysis of space geodetic data using the GEOSAT software. In 2012 NMA has taken over the full responsibility for the GEOSAT software. This implies that FFI stopped being an IVS Associate Analysis Center in 2012. NMA has been an IVS Associate Analysis Center since 28 October 2010. NMA's contributions to the IVS as an Analysis Centers focus primarily on routine production of session-by-session unconstrained and consistent normal equations by GEOSAT as input to the IVS combined solution. After the recent improvements, we expect that VLBI results produced with GEOSAT will be consistent with results from the other VLBI Analysis Centers to a satisfactory level.

1. Introduction

A number of co-located geodetic stations with more than one observation technique have been established. In principle, all instruments at a given co-located station move with the same velocity, and it should be possible to determine one set of coordinates and velocities for each co-located station. In addition, a constant eccentricity vector from the reference point of the co-located station to each of the individual phase centers of the co-located instruments 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 nearly independent of water vapor, gives new information which will help in the de-correlation of atmospheric and other solve-for parameters and will 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 provided by the GEOSAT software developed by FFI [1, 2]. GEOSAT is also useful for single technique analysis. The VLBI module of GEOSAT is now further developed by the NMA [5]. The goals are both to act as an IVS Analysis Center delivering session-by-session unconstrained and consistent normal equations to the IVS Combination Center and to provide quality control for the different modules used in GEOSAT.

2. The GEOSAT Software and Analysis Activities in 2012

The NMA has during 2012 continued the work of making the VLBI module of the GEOSAT software compatible with other VLBI analysis software that delivers results to IVS. In addition, there is a lot of activity going on at NMA to further develop the multi-technique software GEOSAT (see the FFI TDC 2011 annual report).

One of the first challenges that had to be solved was how to extract an unconstrained SINEX solution from the Upper-Diagonal UD Kalman filter solution produced by GEOSAT. A first test solution was sent to the IVS Combination Center in autumn 2009. During 2010 several solutions

covering all VLBI sessions with at least four stations from the start of 1994 to the end of 2009 were submitted to the IVS Combination Center. The first solution was presented at the 6th IVS General Meeting, in Hobart, Australia [5]. The overall agreement between the NMA-GEOSAT solution and the solutions from the other ACs was satisfactory for this first comparison. However, some discrepancies were found. There were some systematic differences in the nutation parameters, which in our latest comparisons seem to have vanished. A misinterpretation of the NGS-format led to systematic differences in UT1-UTC. Systematic differences in station heights have also disappeared in the latest comparison mostly due to the use of the VMF1 [4] model instead of 3D ray tracing. We also noticed more noise in the GEOSAT-derived EOP compared to results from the other software packages. The largest "EOP-outliers" disappeared after some manual editing of the observations. Some other "EOP-outliers" were removed after a manual introduction of clock breaks in the analysis.

3. Plans for 2013

Our plan is to go through the VLBI data from the start of 1994 to the present and to perform a detailed manual editing of outliers. We expect that this will contribute to a reduction of the EOP "noise level". When the editing is completed, a new set of normal equations will be submitted to IVS for a test combination. We hope (and expect) that the results then will be at the level of the other IVS ACs. As soon as the GEOSAT solution is in satisfactory agreement with the other solutions, NMA will start to deliver unconstrained normal equations in the SINEX format to the IVS Combination Center on a routine basis.

Unlike most of the other VLBI analysis software GEOSAT is based on a UD-Kalmanfilter. This allows the stochastic behavior of the system to be changed. NMA will test different stochastic parameters especially for the troposphere. Station and epoch dependent stochastic parameters based on input from numerical weather models and IGS tropospheric products will be tested and evaluated. Tests of different models are also planned — for instance, a comparison of results using VMF1 and 3D ray tracing.

Producing VLBI solutions for IVS [3] is the first part of a larger strategic plan from NMA. The next step is to include other geometric geodetic techniques (GNSS, SLR, and DORIS) in a common solution where the different techniques are combined at the observation level. The long-term goal of this large effort is to also include data from the gravity satellites GRACE and GOCE and from altimeter satellites.

4. Staff

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