CONTRIBUTION OF THE COMPLETE GLONASS CONSTELLATION TO THE ESTIMATION OF NUTATION RATES

M. KUDRYASHOVA, R. WEBER, H. SCHUH, S. ENGLICH
Institute of Geodesy and Geophysics Vienna University of Technology
Gusshausstrasse 27-29, E128/1, A-1040 Wien, Austria
e-mail: mvk@mars.hg.tuwien.ac.at, robert.weber@tuwien.ac.at

ABSTRACT. It is well known that nutation rates can be derived from precise distance measurements to Global Navigation System (GPS) satellites gained within a global reference station network. The main goal of this work is to study the potential contribution of new satellite constellations (like revitalized GLONASS and upcoming GALILEO) to the estimation of nutation rates w.r.t. GPS-only based nutation rates. For this purpose two series of nutation rates have been produced: the first one is based on the GPS observations only and the second – on the observations of two satellite systems (GPS and GLONASS). In order to derive these series we used simulated observations produced by means of the Bernese v.5.0 software [1]. This investigation highlights the impact of the geometry and gain in number of observations due to new or fully upgraded constellations on the overall error budget and in special on the correlation coefficients between nutation rates and radiation pressure parameters.

1. DESCRIPTION OF SOLUTION

For our analysis we produced two series of nutation parameters: a GPS-only based solution and a GPS+GLONASS combined solution. To generate the first series we used real GPS satellite orbits and clock information delivered by the CODE AC of the IGS. The second series have been established on the basis of simulated orbits of the 24 satellites of a complete GLONASS constellation [2]. In a further step of the analysis we had to simulate observations for both solutions (to obtain comparable results also the GPS observations were simulated).

Characteristics which are common for both solutions are summarized below:

- software: BERNESE 5.0 (for simulation and processing of observations);
- network: 116 stations from IGS realisation of ITRF2005;
- nutation offsets w.r.t. IAU 2000 nutation model;
- estimated parameters: corrections to orbit parameters (Keplerian elements and radiation pressure parameters), tracking station coordinates and nutation rates;
- pre-eliminated parameters: clocks and troposphere parameters, ambiguities;
- data span: 12.09.2005 - 27.09.2005 (CONT05 campaign).

Since we processed simulated observations we had to introduce two changes into our standard procedure to estimate nutation rates from GNSS observations. The standard procedure and changes are shown in the Fig.1. Firstly, we had to adapt the orbit fitting procedure because the virtual a priori orbit information could not be fitted by Bernese force models with reliably small residuals. Secondly, due to simplifications, the produced orbits experience noticeable gaps at the day borders. As a result, the estimation of nutation rates has to be made on the basis of one-day solutions.

2. RESULTS AND DISCUSSION

As expected the introduction of a simulated GLONASS constellation increases the number of observations almost twice (by $\approx 90\%$ under the assumption of an observation network fully equipped with hybrid GPS+GLONASS receivers). This implies in case of non-existing biases (a very crude assumption) a decrease of the rms of the estimated parameters according to the square-root law. The numbers in

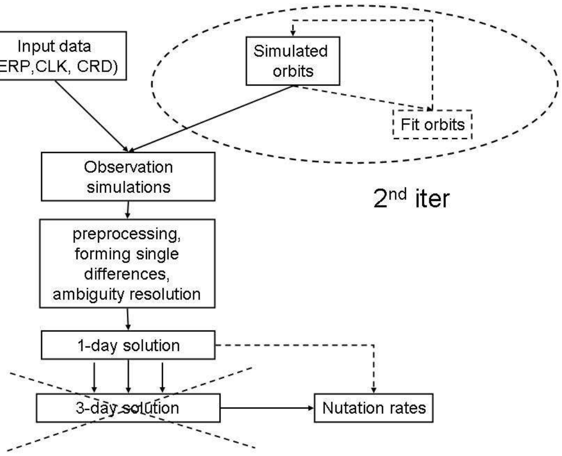

Fig1. Data-flow diagram. The solid line boxes and arrows sketch our standard procedure, the dotted line - changes have been made for simulations.

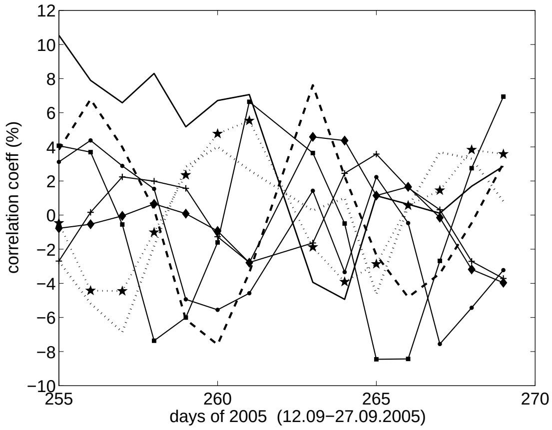

Fig2. Correlation coefficients between D0 term of the RPR parameters and daily nutation rates in obliquity for the satellites of the first GLONASS orbital plane (each line corresponds to one of the satellites) in case of GPS+GLONASS solution.

table 1 are therefore raw factors which demonstrate the relation of how the formal errors of the nutation rates might decrease in case of including observations to the GLONASS satellites and omitting of potential intersystem biases. The unit weight of the solutions is of course governed by the quality of the orbit fit which should be at the 1cm level to achieve a 0.1mas/day accuracy of the rates.

	GPS-only			GPS+GLONASS		
date	$\sigma_{\Delta\psi}$	$\sigma_{\Delta\varepsilon}$	N_{obs}	$\sigma_{\Delta\psi}$	$\sigma_{\Delta\varepsilon}$	N_{obs}
13.09	171	80	910.272	118	54	1.697.008
14.09	170	81	910.276	117	54	1.705.278
15.09	171	81	909.886	119	54	1.697.606
16.09	171	82	910.404	116	54	1.705.718
17.09	170	82	910.402	118	54	1.696.540

Table 1: Ratio of the formal errors and observation numbers of the nutation rates estimated for GPS-only and GPS+GLONASS solutions (for several days).

The correlation coefficients between nutation rates and radiation pressure parameters could serve as a real measure of the contribution of improved geometry of an additional (w.r.t. GPS) satellite system. Note, that among the estimated radiation pressure parameters (RPR), only D0, X0, Y0 and XC, XS terms have a non-negligible correlation with nutation rates. Fig. 2 presents the correlations between the nutation rate in obliquity and the D0 term for a combined GPS+GLONASS scenario. It can be seen that the correlation coefficients are about -0.1 to +0.1 for the GPS+GLONASS solution. We should note that the corresponding correlations for a GPS-only solution are in the range of up to -0.25 and +0.25.

Acknowledgements. First author express gratitude to the Descartes/Nutation Advisory Board for financial support of this work (in frame of the grant GALILEO/NUTATION).

3. REFERENCES

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