ESTIMATION OF NUTATION USING THE GPS

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1. INTRODUCTION

GPS measurements obtained from the global IGS network are undoubtedly a valuable source for the determination of ERP series. This series are at the one hand of high quality ($\sigma_{xp,yp} \approx 0.1mas$; $\sigma_{LOD} \approx 0.02msec/day$) because of the more or less regular distribution of the active IGS tracking sites (curently about 140 stations). Moreover the uninterrupted coverage of almost 10 years with daily estimates is also of importance for detailed studies.

In February 1994 CODE, one of the seven Analysis centers of the IGS started to derive nutation rates in addition to polar motion and the routinely estimated UT1-UTC rates. In 1999, a set of nutation amplitude corrections for 34 periods with respect to the IERS96 model as well as the IAU1980 model was presented by (Rothacher et al.,1999) based on 3.5 years of data. It has been demonstrated that GPS is especially sensitive to periods up to about 20 days. This overview deals with preliminary results of the most recent update of the published nutation amplitude corrections by taking into account 6 years of observation data and focusing on the 13.66 days term.

2. ESTIMATION OF NUTATION RATES

Contrary to polar motion, offsets in the three remaining earth orientation components ($\Delta\varepsilon$, $\Delta\psi$, UT1-UTC) are fully correlated with the orbital parameters describing the orientation of the orbital planes of the satellites (ascending node, inclination, and argument of latitude). Nevertheless, an almost 'perfect' force model would describe the satellite orbits accurately enough, at least over an interval of a few days (3 days arcs at CODE) to allow for the determination of EOP-drift parameters. In reality major biases in the rate estimates show up at the satellites revolution period or at annual and semi-annual periods due to solar radiation pressure.

Daily nutation rates in longitude and obliquity estimated from GPS data over the past 6 years are available now. All rates are corrections to the IAU 1980 Theory of Nutation. The series seems to become somewhat noisier at the end of 1996, caused by a change of the orbit model in October 1996. The formal errors of the estimates grow by a factor of about 2-3 because of correlations to the newly added orbit parameters. Nevertheless, (Rothacher et al.,1999) have shown in a thorough discussion, that nutation corrections of similar quality can be obtained with both orbit models.

3. ESTIMATION OF NUTATION AMPLITUDES

To decribe amplitude corrections A_{ij}, A_{oj} to nutation terms from a series of nutation rates $\delta\Delta\varepsilon'$ and $\delta\Delta\psi'$ we use the following formulation (e.g. Weber, 1999)

$$\delta\Delta\varepsilon(t)' = -\sum_{j=1}^{n} A_{ij}^{\varepsilon} \sin\theta_j(t)\frac{\partial\theta_j}{\partial t} + \sum_{j=1}^{n} A_{oj}^{\varepsilon} \cos\theta_j(t)\frac{\partial\theta_j}{\partial t} \tag{1}$$

$$\delta\Delta\psi(t)' = -\sum_{j=1}^{n} A_{oj}^{\psi} \sin\theta_j(t)\frac{\partial\theta_j}{\partial t} + \sum_{j=1}^{n} A_{ij}^{\psi} \cos\theta_j(t)\frac{\partial\theta_j}{\partial t} \tag{2}$$

The angles θ_j denote a linear combination of the Delauny variables and n is the number of nutation terms taken into account. The A_{ij}, A_{oj} are usually called in-phase and out -of-phase components, which can be obtained by a least squares adjustment using the GPS nutation rates as pseudo-observations.

Figure

The diagram presents the first results in evaluating this new enlarged nutation rate series. A comparison of the nutation in-phase and out-of-phase components for the 13.66 days period given in various well-known models with the most recent model by Souchay/Kinoshita (1997.2;SKV972) shows the excellent agreement and the increasing convergence of the GPS solutions with SKV972.

We may conclude that even now GPS allows an independent check of present-day nutation models and VLBI results at the high frequency end of the spectrum. In future a combination of the VLBI and the GPS series at the postprocessing or even at the observation level might be extremely promising.

4. REFERENCES

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