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Introduction

The CRC is an integral part of the Center for Earth Dynamics Research (CEDR) that joins four Czech institutions active in astronomy and geosciences research. The combination research is maintained principally in two different directions. On the one hand, we combine some of the Earth Orientation Parameters using the ‘combined smoothing’ algorithm that we recently proposed, without changing the underlying reference frames (terrestrial, celestial). On the other hand, we follow the direction of combining non-SINEX particular solutions of different techniques to determine the Earth Orientation Parameters simultaneously with station coordinates.

Combination of EOP

We used our original combined smoothing algorithm (Vondrák & Cepek, 2000), with slight modifications to account for long-periodic (60 days and longer) systematic errors in GPS observations, to produce several more combinations in 2005.

We made a combination of the length-of-day (LOD) measured by GPS with UT1–TAI measured by VLBI and found that again the combination with GPS helps to improve the VLBI-only solution (Vondrák & Ron, 2005). We found that almost all observed variations of LOD for the periods going from several tens of days to 11 years can be explained by the combined effects of Earth tides and the atmosphere. The comparison of the solution with excitations by the atmosphere and oceans (Kouba & Vondrák, 2005) reveals that it yields the best correlation in short-period domain, of all series compared (IERS Bull. A, C04, IGS, SPACE93).

IGS uses empirical calibration of GPS-based LOD to VLBI-based UT1–TAI, in order to remove long-periodic errors of the former series. We attempted to find a more optimal method of combining VLBI with GPS to obtain mutually consistent series of UT1 and LOD. To do so, we used the method of combined smoothing to combine the VLBI-based values of UT1–TAI (IVS solution) with two GPS-based series of LOD, one calibrated (IGS) and one not calibrated (CODE) with respect to VLBI. These solutions are then compared with the atmospheric and oceanic excitation. The combination of VLBI-based UT1–TAI with GPS-based LOD helps to improve the VLBI-alone solution, both in resolution and accuracy. The combination demonstrated that the accuracy is consistent with formal errors, for both techniques, only when a priori calibration of GPS to VLBI is made. The correlation of combined LOD with atmospheric and oceanic excitation is very good, for shortest periods it is the highest of all series studied. Even if the calibration of GPS against VLBI is not used, the method of combined smoothing assures that the combined LOD is consistent with VLBI in a long-period sense

(Vondrák et al., 2006).

We also combined celestial pole offsets in the interval 1994.3–2004.6 (measured by VLBI) with their rates (measured by GPS), first referred to the old precession-nutation model IAU1980, and then transformed to the system of the new model IAU2000A. In the new system, the Free Core Nutation (FCN) becomes dominant. The period of FCN estimated from resonance effects from the combined VLBI/GPS solution is equal to 430±0.11 mean solar days (Vondrák et al. 2005).

Combination of EOP and station coordinates

A method of non-regular combination of different techniques to obtain simultaneously station coordinates and Earth Orientation Parameters was further developed. The method is based on combining position vectors of the stations in the celestial reference frame, with constraints to separate celestial pole offset from polar motion and to tie EOP between different epochs. Station coordinates are combined using seven-parametric transformation for each input technique instead of transforming the coordinates themselves.

Some techniques provide the IERS Combination Pilot Project (CPP) data base with the unconstrained data. This is not suitable for our case. Therefore, the ilrsb and ign-wd04 solutions were used for SLR and DORIS, respectively, instead of those collected in CPP, while for VLBI, the data is recovered from CPP singular normal equations using vtrf2005 station coordinates.

Basically, two approaches were studied – the short-term and the long-term combinations. The main difference of the two approaches is, that the former reflects short periodic changes in both the EOP and the station coordinates, while the latter accents general trends in the unknowns.

i) The input data was combined piecewise in shorter (e.g. monthly) periods. This reduces the effect of systematic biases, on one hand, but it yields discontinuities of EOP between the successive blocks, on the other. The discontinuities can be reduced substantially when data overlaps are applied. Namely, the monthly solutions were derived from two-monthly data. Newly, a trapezoid windowing was applied, so that the data in the overlaps is weighted from 1 at the middle to 0.1 at the ends (Pešek & Kostelecký, 2005, 2006).

ii) Good quality data allows the combination over a long period, in one step. In this case, rates of the transformation parameters are introduced to derive evolution of the station coordinates (Kostelecký & Pešek, 2006).

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