

3.6.2 Combination Research Centres

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Introduction The CRC is an integral part of the Center for Earth Dynamics Research (CEDR) that joins five 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 2004.

We combined celestial pole offsets in the interval 1994.3 – 2003.8 (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. Its period in the celestial reference frame has an average value of 435 days, if only VLBI observations are used in the interval 1984 – 2003. From the combined solution however follows that the period is, after 1994, slightly longer, of about 455 days (Vondrák and Weber 2004). In addition we found small but statistically significant corrections of the IAU2000A nutation model with periods 18.6 and 9.3 years, and also 365.26, 182.56, 31.81, 27.55, 13.66, 13.63 and 5.64 days.

Our more recent combination of celestial pole offsets, covering a longer interval (1994.3 – 2004.6), confirmed these findings and hinted that the FCN period was even longer, 460 days (Vondrák and Ron 2004, Vondrák et al. 2004, Vondrák and Ron 2005). This value is in contradiction with the model IAU2000A, but in surprisingly good accordance with the older Wahr’s model IAU1980. The corrections of 9 nutation terms were derived whose amplitudes attain a few tens of microarcseconds.

We also made a combination of the length-of-day 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 2004, Vondrák and 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.

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 tested using VLBI, GPS, SLR and Doris data, collected for IERS Sinex Combination Campaign. 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 (Pešek & Kostecký 2004).

Formerly it was found that the effect of systematic biases in the input data can be reduced by combining them piecewise in shorter (e.g. monthly) periods. Nevertheless this approach yields discontinuities of EOP between successive blocks. These biases practically completely disappear when the solution is derived from the data covering a longer period, and as a result only a middle part is used. Namely, the monthly solution is derived from two-monthly data.

The effect of combination on EOP is characterized by increments from the adjustment of 0.09 mas and 0.034 ms for polar motion and Universal Time, respectively. Uncertainty of station coordinates decreased from 0.050 m to 0.039 m.

The method was also applied to IERS Combination Pilot Project data with still only preliminary results.

In 2004 an object-oriented mathematical model for a general unconstrained adjustment of observational data was tested and implemented on combinations of coordinates obtained from different techniques (Cepek & Pytel 2004). Although most of the solutions seemed to be satisfactory and resulted in coordinates with reasonable covariance matrix, some combinations led to totally singular systems.

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