3.6.2.4 Forschungseinrichtung Satellitengeodäsie, Technical University of Munich (FESG)

1. Introduction

At FESG as a Combination Research Centre (CRC) mainly the following research topics were covered during 2003:

- IERS Campaign to align EOPs to ICRF/ITRF2000,
- IERS SINEX Combination Campaign,
- Analysis of subdaily ERPs from GPS and VLBI,
- Analysis of nutation rates from GPS and nutation offsets from VLBI,
- Combination of GPS and VLBI solutions for the CONT'02 campaign.

2. IERS Campaign to Align EOPs to ITRF2000/ICRF

The work concerning the "IERS Analysis Campaign to align EOPs to ITRF2000/ICRF" was finished at the beginning of 2003 with a presentation at the EGS General Assembly 2003 in Nice. Most of the differences between the submitted EOP series were not due to the different alignments to ITRF2000 station coordinates, but due to different formats and sample rates, unevenly spaced VLBI data with larger gaps, incorrect signs in UT1–UTC (LOD) estimations from satellite techniques and the use of different interpolation schemes. Compared to these problems the influence of the constraining method seems to be small. As a major result, we could show that there is a considerable inconsistency of about 0.2 mas in the y-pole coordinate between the official IERS C04 series and the newly computed series correctly aligned to ITRF2000 (see Figure 1).

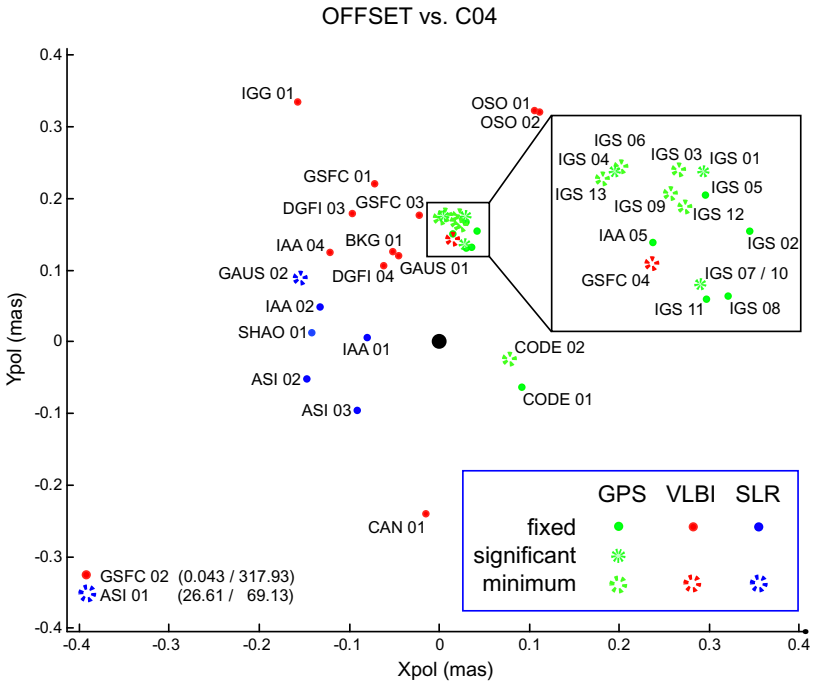

Fig. 1:X- and Y-pole offsets w.r.t. the C04 series for EOP series from GPS, VLBI and SLR solutions that were correctly aligned to ITRF2000 using different constraints. (For a colour version of this figure see the online version of this report at www.iers.org.)

Therefore, the official IERS products (C04 series and ITRF2000) are not really consistent at the present accuracy level. Only a rigorous combination of EOPs and ITRF can solve this problem. This result is very comparable to associated studies within the IERS SINEX Combination Campaign. The results of this campaign will be incorporated into the IERS Combination Pilot Project and the studies on combination strategies will be continued within this new project.

3. IERS SINEX Combination Campaign

Since the campaign itself started in May 2002, we already reported about the work concerning this campaign in the IERS Annual Report 2002. The main task performed during 2003 was the incorporation of an SLR solution series into the comparison and combination studies. Only one solution series was selected for each of the three techniques (GPS, VLBI and SLR), namely the GPS solution from CODE, the VLBI solution from DGFI and the SLR solution from ASI. The results of the inter-technique combination were presented at the EGS General Assembly 2003 in Nice (Thaller, Rothacher 2003a) and at the Geotechnologien-Statusseminar 2003 in Munich (Thaller, Rothacher 2003b). At this stage the connection between the three techniques was realized only via the Earth rotation parameters (x-/y-pole, UT1–UTC), as the application of the local tie information was implemented into the software at a later date (see the last topic of this report). The studies showed once more quite clearly that the y-pole of the results derived from the individual space geodetic techniques are shifted by about 0.2 mas compared to the C04 series (see Figure 2).

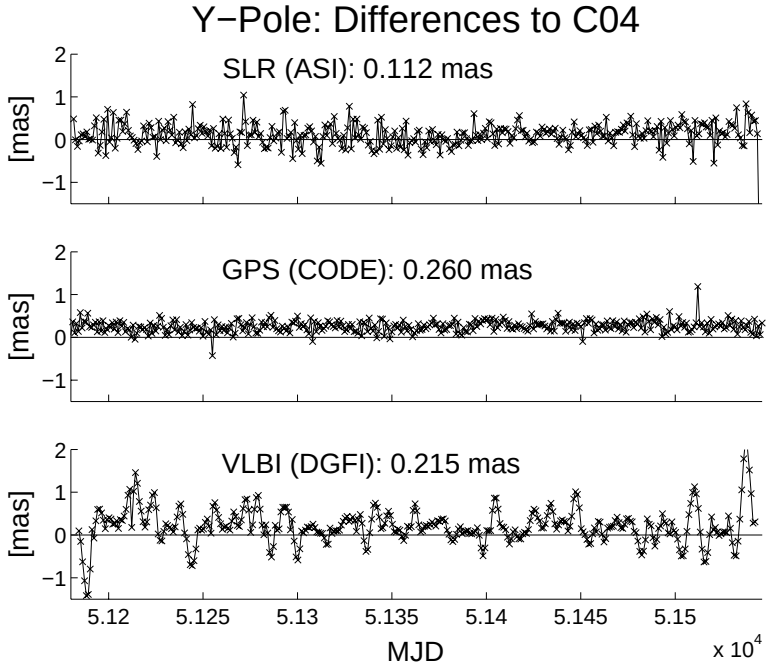

Fig. 2: Y-pole offsets w.r.t. the C04 series for EOP series from GPS, VLBI and SLR solutions submitted to the IERS SINEX Combination Campaign.

4. Analyses and Combination of Subdaily ERPs from GPS and VLBI

The most recent harmonic analysis of subdaily ERP series from GPS and VLBI shows a very good agreement with studies of the subdaily tidal excitation in polar motion and length of day (LOD). Nevertheless, there are still some inconsistencies between the results from GPS and VLBI. Besides a combination of different space geodetic techniques in the various analysis processes a combination of the original subdaily time series in advance of the time series analysis could be useful. Therefore, we are developing a new combined subdaily time series from GPS and VLBI. This combined time series should remove problems with large data gaps and unevenly spaced data, mainly from VLBI. Moreover, we can enhance the signal-to-noise ratio. Problems arise from the adjustment of different time variable offsets and different error levels in the two series. In addition, GPS provides only the first derivative of UT1–UTC. On the basis of Jan Vondrak's combined smoothing (Vondrak, Cepek 2000), we designed a three-step combination. In a first step we remove the low frequency variations of each single time series and adjust a kind of running mean level for both series. In a second step both time series are combined in a weighted least squares estimation with a very weak smoothing in order to keep as high frequencies as possible. In the last step we resubstitute a mean low frequency part. For UT1–UTC, all these steps are done with the time integral of LOD from GPS. Preliminary results of this combination attempt are very promising. The combined subdaily time series shows a much smaller scatter and RMS than each individual time series, even though the tidal harmonic analysis yields the full information on subdaily tidal excitation. Now we are testing several parameter configurations for the three mentioned steps to identify the strength and weakness of different combination schemes.

5. Combination of GPS and VLBI for the CONT'02 Campaign

CONT'02 was a 2-weeks campaign of continuous VLBI measurements during October 2002 with eight participating stations. In close cooperation with the DGFI – an IERS CRC as well – the VLBI data of this campaign were combined with the data of a global GPS network on the normal equation level. Since not only station coordinates and Earth orientation parameters are common to GPS and VLBI, but also troposphere parameters can be determined by both techniques, troposphere zenith delays were estimated every two hours for each station and horizontal gradients were set up once per day for each station. The studies comprise the influence of the local tie information on the combination results, the comparison and evaluation of the subdaily ERP results (2-hour resolution) with other subdaily models as, e.g., the model of the IERS Conventions (Ray96), the handling of the troposphere parameters in the combination, and the impact of using absolute instead of relative phase centre variations in the GPS analysis (for satellites and ground stations).

First results were presented at the IUGG General Assembly 2003 in Sapporo (Thaller et al. 2003c). From studies of the eight local ties we concluded that only the local tie for the station Kokee Park seems to be too bad for the combination. The comparison of the troposphere parameters estimated independently by both techniques looked quite promising (see Hartebeesthoek as one example in Figure 3), and the results are, apart from a small bias, in good agreement as well with the data from the water vapor radiometer at Onsala (Rothacher et al. 2003). A combination of troposphere parameters is still in progress and the systematic biases have to be investigated in more details. Therefore, a satisfactory combination for the troposphere could not be finalized till the end of the year. With the chosen subdaily resolution for the ERPs, the Ray96 model can be seen as an independent tool for evaluating the ERP results, because this model was derived from altimetry and not from GPS and VLBI. It turned out that in most cases the GPS/VLBI results match the model reasonably well.

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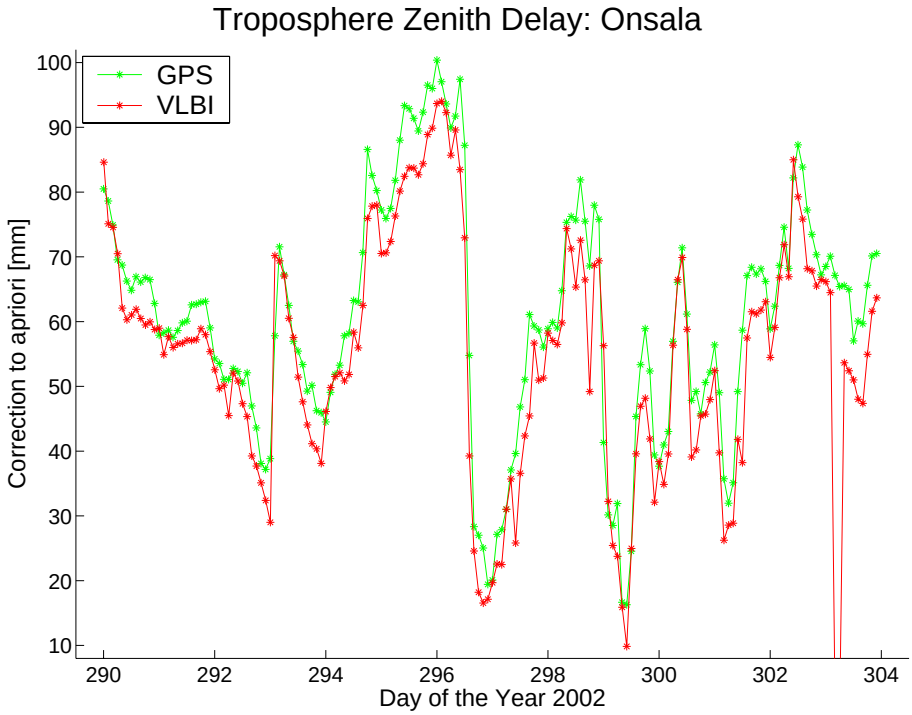

Fig. 3: Troposphere zenith delays from GPS and VLBI for the CONT'02 Campaign. The bias of about 4 mm between GPS and VLBI is caused by the height difference of 13.7 m between the techniques. (For a colour version of this figure see the online version of this report at www.iers.org.)

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