Federal Agency for Cartography and Geodesy

Combination of IVS intensive sessions – approach, benefit, and operability

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Motivation and Objective

Combined VLBI products are well established in the IVS for station coordinates and Earth Orientation Parameter (EOP), given that a combined product shows improved statistics in comparison to a single individual solution (c.f. [1], [2]). Improving and expanding the range of combined products is one of the tasks of the IVS Combination Center. So far, only daily 24h sessions have been used to generate IVS combined products. The aim of this study is to evaluate whether IVS intensive 1h sessions benefit from a combination on a comparable level as 24h sessions do, to carve out a combination approach and to evaluate if an operational product could be established.

Approach

In analogy to the combination approach for 24h sessions, the Intensives combination is based on datum free normal equations provided in SINEX format. The contributions of various IVS Analysis Centers (AC) are stacked to generate a combined solution, as shown in Figure 1. The short observation period limits the number of solvable parameters to dUT1 and necessitates the following adjustments (compared to 24h combination):

- Station coordinates, polar motion, and LOD are fixed to a priori values.
- Station coordinates transformed to a priori values taken from recent VTRF[1] (due to missing stations in ITRF2014).
- Pole coordinates are introduced using IGS rapid solutions[2] (17 - 41 hours latency) for higher accuracy.
- Weighting factors for individual solutions are estimated using a σ^2 approach (in contrast to a variance component estimation for 24h sessions).

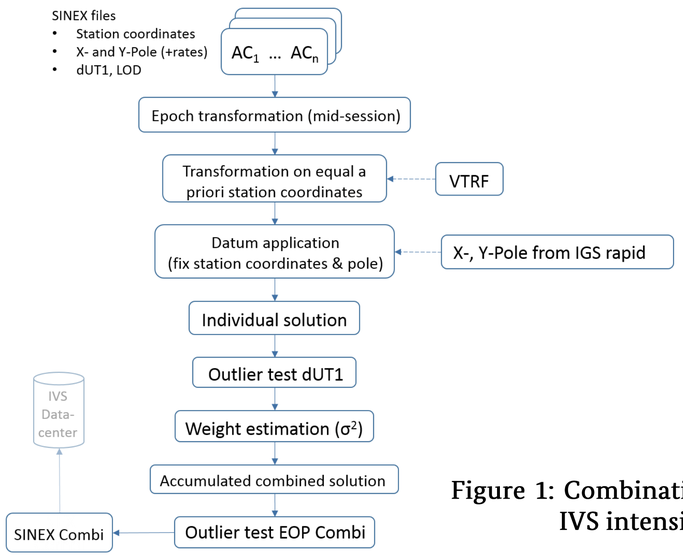

Figure 1: Combination scheme for IVS intensive sessions

Input Contribution

Currently, SINEX files of IVS Intensives are not yet consistently available in the IVS data center. We thus include those SINEX files that are available and suitable and, additionally, SINEX contributions provided by other ACs on request. Altogether we included four contributions using two different software packages. The input contributions comprise each type of Intensives from 2017. Overall 258 sessions are used for the comparisons (equal sessions for all ACs).

Results

Figure 2 shows the dUT1 residuals from each of the contributing ACs and the combined solution with respect to IERS 14C04 series[3]:

- Slight offsets are present for two ACs (see also Table 1).
- Slight irregularities between 2017.9 and 2018.0 are visible.

[1] https://ccivs.bkg.bund.de/vtrf; [2] http://www.igs.org/products; [3] ftp://hpiers.obspm.fr/iers/eop/eopc04/

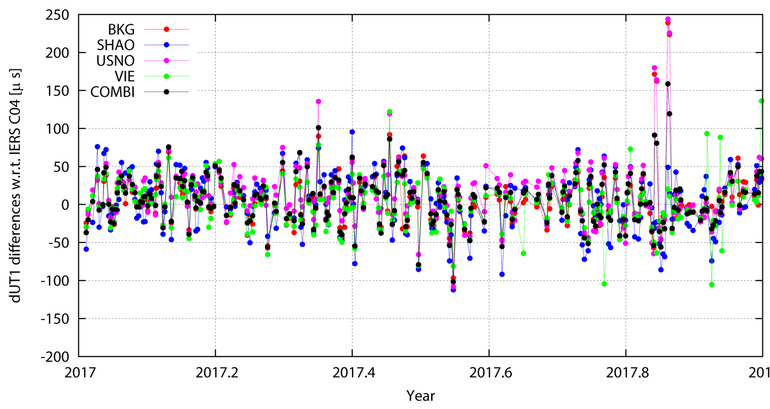

Figure 2: dUT1 residuals w.r.t. IERS 14C04

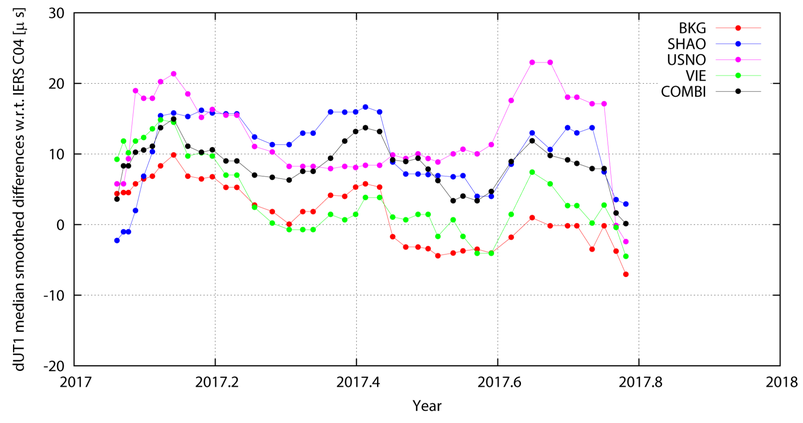

Figure 3: dUT1 median smoothed residuals w.r.t. IERS 14C04

Table 1: RMS and Offset for dUT1 w.r.t. IERS 14C04 series (258 equal sessions for each AC)

AC	RMS [µs]	Offset [µs]
BKG	36.9	5.1
SHAO	37.3	7.7
USNO	38.6	10.9
VIE	33.4	1.9
COMBI	32.0	5.6

These first results show that combining individual IVS Intensives is a considerable way to introduce an improves dUT1 product in terms of statistic. The variability tends to attenuate for the combined solution.

Open issues and future plans

- Small number of IVS ACs are currently analyzing and submitting Intensives SINEX files operationally.
- Including more AC contributions (esp. divers software packages) is highly desired.
- Adjusting a weighting strategy considering different software packages needs to be implemented.
- Considering an operational combined product (depending on availability of individual AC contributions and achievable latency) to be established.

Acknowledgment

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References

[1] Böckmann S, Artz T, Nothnagel A, Tesmer V (2010) International VLBI service for geodesy and astrometry: Earth orientation parameter combination methodology and quality of the combined products. J Geophys Res 115. doi:10.1029/2009JB006465

[2] Bachmann S, Thaller D, Roggenbuck O, Lösler M, Messerschmitt L (2016) IVS contribution to ITRF2014. J Geod 90(7):631–654. doi:10.1007/s00190-016-0899-4

Website of the IVS Combination Centre at BKG: https://ccivs.bkg.bund.de/