COMPARISON OF VLBI-BASED LUNI-SOLAR NUTATION TERMS

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I. Introduction

Very Long Baseline Interferometry (VLBI) is the only space geodesy technique that can directly observe the celestial pole offsets. These values are time-dependent corrections to the IAU200A/2006 precession-nutation model that are estimated by different VLBI analysis centres. The celestial pole offsets, together with the rest of Earth Orientation Parameters (EOP) are combined by the IERS and disseminated in official series.

The purpose of this contribution is to compare the differences between the celestial pole offsets from different VLBI-based series consistent in terms of software configuration. Series provided by the International VLBI Service for Geodesy and Astrometry (IVS, Nothnagel et al., 2017) and combined solutions are analysed. The celestial pole offsets estimation series from each source are used as pseudo-observations for a least-square harmonic fitting to obtain different corrections to nutation terms.

II. Theoretical background

The Earth Orientation Parameters constitute the key input for the coordinate transformation between the Geocentric Celestial Reference System (GCRS) and International Terrestrial Reference System (ITRS). These parameters are the components of the polar motion (x_P, y_P) , the difference UT1-UTC and the celestial pole offsets (dX, dY) with respect to IAU 2006/2000A precession/nutation model.

From VLBI-based series of celestial pole offsets, it is possible to perform a least-square harmonic fit of the main nutation terms of the IAU2000A model:

$$dX = \sum_{i=1}^{42}\left[a_{real,i}\cos\left(ARG_i\right) - a_{imag,i}\sin\left(ARG_i\right)\right] \qquad dY = \sum_{i=1}^{42}\left[a_{real,i}\sin\left(ARG_i\right) + a_{imag,i}\cos\left(ARG_i\right)\right]$$

where ARG_i are linear combinations of the fundamental arguments of the luni-solar nutation theory.

III. Software analysis

Table 1 presents a summary of the estimation strategies of the IVS analysis centers whose products are used in this work. This information is available at IVS ftp. Solutions not using ICRF2 as celestial frame have not been included in the analysis. Table 2 includes the list of the 42 nutation harmonic terms to be fitted. Columns *ki* correspond to the multiplier factor of Delaunay arguments.

Analysis center/solution	BKG	GFZ	GSF	IAA	OPA	USN
Software package	Calc 10.0/Solve	VieVS@GFZ	Calc 11.0/Solve	OCCAM/GROSS	Calc 11.0/Solve	Calc 11.0/Solve
Celestial frame	ICRF2	ICRF2	ICRF2	ICRF2	ICRF2	ICRF2
Terrestrial frame	ITRF08	ITRF14	ITRF14	ITRF14	ITRF14	ITRF14
IERS Conventions	2010	2010	2010	2006	2010	2010
Precession/nutation model	IAU2006/IAU2000A	IAU2006/IAU2000A	IAU2006/IAU2000A	IAU2000A/IAU2000A	IAU2006/IAU2000A	IAU2006/IAU2000A
Estimation model	Least squares	Least Squares	Least squares	Kalman Filter	Least Squares	Least squares
Troposphere	VMF1	VMF1	VMF1	VMF1	VMF1	VMF1

Table 1. Estimation strategies of different IVS analysis centers.

i	$k_{i,1}$	$k_{i,2}$	$k_{i,3}$	$k_{i,4}$	$k_{i,5}$	*Period (days)*
1	0	0	0	0	1	-6798.38
2	0	0	0	0	-1	6798.38
3	0	0	0	0	2	-3399.19
4	0	0	0	0	-2	3399.19
5	2	0	-2	0	-2	-1615.75
6	-2	0	2	0	2	1615.75
7	2	0	-2	0	-1	-1305.48
8	-2	0	2	0	1	1305.48
9	2	0	-2	0	0	-1095.18
10	-2	0	2	0	0	1095.18
11	0	-1	0	0	-1	-386.00
12	0	1	0	0	1	386.00
13	0	-1	0	0	0	-365.26
14	0	1	0	0	0	365.26
15	0	-1	0	0	1	-346.64
16	0	1	0	0	-1	346.64
17	0	0	-2	2	-2	-182.62
18	0	0	2	-2	2	182.62
19	0	-1	-2	2	-2	-121.75
20	0	1	2	-2	2	121.75
21	1	0	0	-2	0	-31.81

i	$k_{i,1}$	$k_{i,2}$	$k_{i,3}$	$k_{i,4}$	$k_{i,5}$	*Period (days)*
22	-1	0	0	2	0	31.81
23	-1	0	0	0	0	-27.55
24	1	0	0	0	0	27.55
25	-1	0	-2	2	-2	-23.94
26	1	0	2	-2	2	23.94
27	0	0	0	-2	0	-14.77
28	0	0	0	2	0	14.77
29	-2	0	0	0	0	-13.78
30	2	0	0	0	0	13.78
31	0	0	-2	0	-2	-13.66
32	0	0	2	0	2	13.66
33	1	0	-2	-2	-2	-9.56
34	-1	0	2	2	2	9.56
35	-1	0	-2	0	-2	-9.13
36	1	0	2	0	2	9.13
37	-1	0	-2	0	-1	-9.12
38	1	0	2	0	1	9.12
39	0	0	-2	-2	-2	-7.10
40	0	0	2	2	2	7.10
41	-2	0	-2	0	-2	-6.86
42	2	0	2	0	2	6.86

Table 2. Harmonic terms and corresponding periods.

IV. Results

The corrections to IAU 2000A model were computed by means of a least-square harmonic fitting after having removing FCN using B16 model (Belda et al., 2016) for the set of solutions aforementioned and also for combined solutions: IVS and EOP 14 C04 (Bizouard et al., 2018). Time span is restricted to to 1993-2016.8, since data before 1993 have poorer precision and temporal resolution (Belda et al. 2016). Estimated amplitude values and the differences with respect to the mean value are shown in Figure 1. Additionally, median amplitudes of the corrections to IAU 2000A model and the range between values are shown in Figure 2 and compared to the results reported by Gattano et al. (2017) and Yao (2013). It should be noted that in Gattano et al. (2017) all IVS solutions were used regardless their configuration, using data starting from 1984. In addition, they fitted their own FCN model. For Yao (2013), the fitted amplitudes correspond to an individual solution, so there is no figure for the range. Although the figures do not show a time dependent magnitud e in abscissa, lines are used for the sake of clarity.

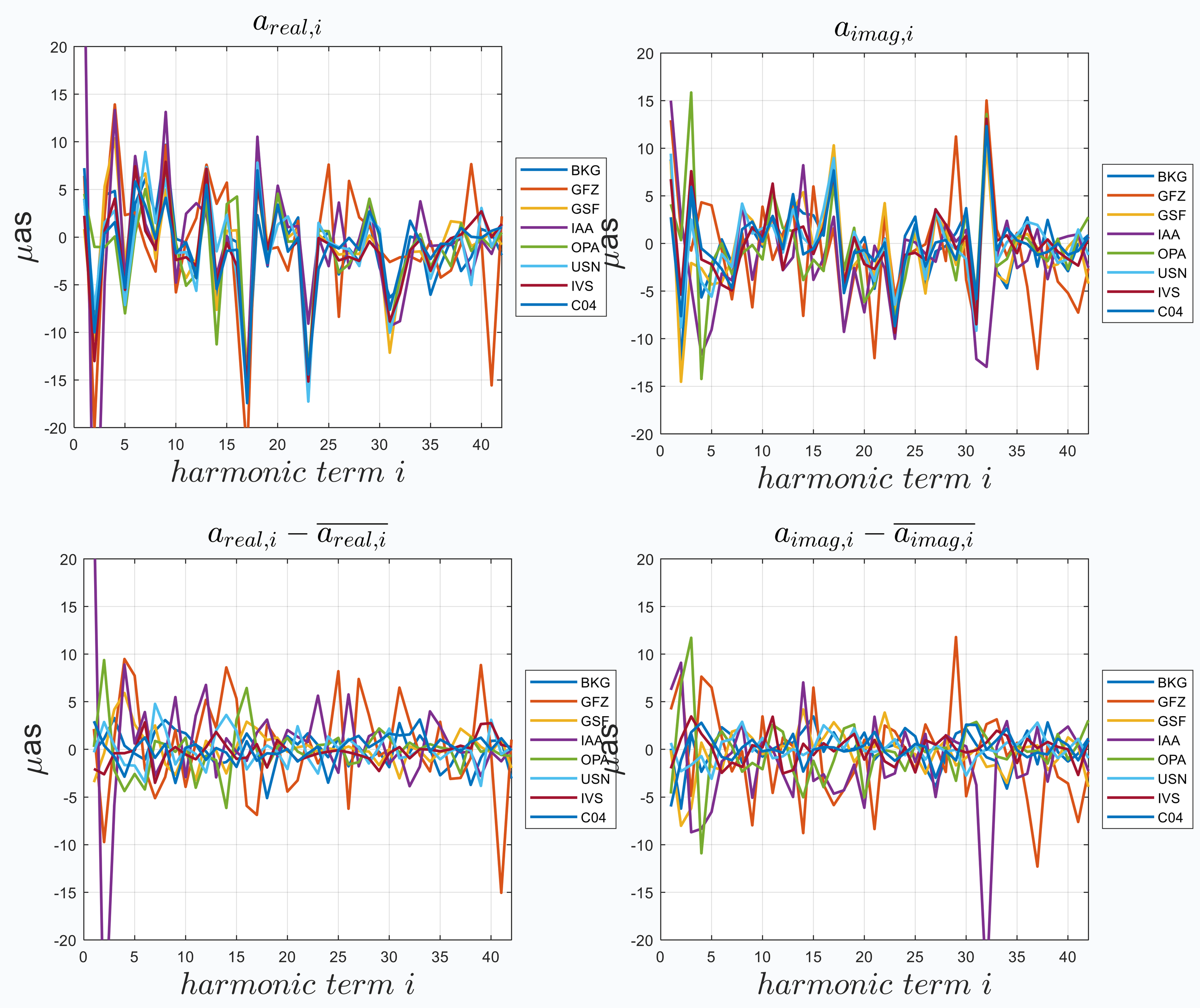

Figure 1. Amplitudes of the corrections to IAU 2000A adjusted to the nutation time series (top) and differences with respect to the mean value (bottom).

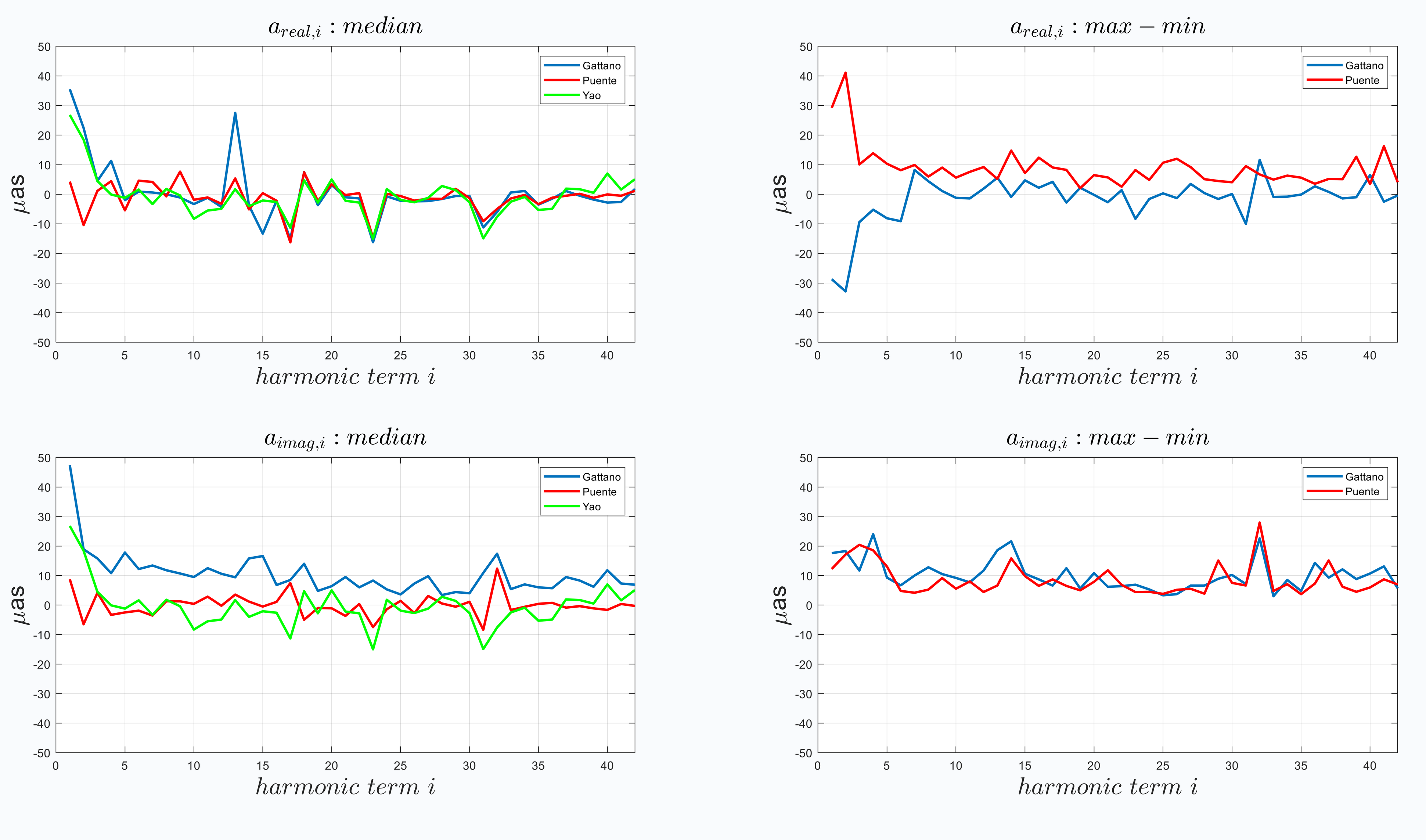

Figure 2. Comparison of the median and range of the amplitudes with respecto to Gattano et al. (2017) and Yao (2013).

V. Conclusions and future work

The results presented in this poster lead to the following conclusions:

- A comparison of the differences between the celestial pole offsets from different VLBI-based has been carried out and corrections to the principal nutations of the IAU 2000A model have been computed. The results show in general a good agreement with similar studies on this topic.
- Disagreement with Gattano's results for the longest nutation periods probably due to the different set-up of the analysis: different set and time span of IVS solutions and different model to remove FCN signal.

In the future, it is expected to add to this analysis GNSS-based estimation of celestial pole offsets (Puente et al., 2018). This would be a valuable contribution to the study of short-period nutation terms.

VI. References

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