ON THE PROCESSING OF VLBI INTENSIVE SESSIONS

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ABSTRACT. Operated every day, intensive VLBI sessions are designed for providing near real-time estimates of UT1. Due to the weak network geometry, nuisance parameters associated with troposphere path delay are generally considered as constant over the full duration of the session. All other quantities are fixed to a priori values, including site coordinates and velocities, source positions, polar motion and nutation. It appears that the analyses of intensives differ from corresponding results obtained with multi-baseline 24-hour VLBI sessions in two major points. First, the postfit rms delays of intensives are significantly higher (40 ps in average) than for larger networks (20 ps in average). Second, the scatter of UT1 is larger by a factor of two. Is there a way of improving these two points? Studies have been undertaken in various directions: using a GNSS-derived polar motion to map the Earth orientation (Ray et al. 2005), improving the nutation by adding an empirical modeling of the nutation offsets to the current nutation model (Malkin 2009, 2011), and modeling the troposphere delay by using 3D troposphere models and direct ray tracing for each observation (Böhm et al. 2010). In the present study, I revisit the results of Malkin by trying a slightly different modeling of the nutation offsets and assessing differently the quality of the results. As well, I investigate the possibility to estimate other parameters, that are traditionally fixed to a priori values in the operational analysis. This study is detailed in an unpublished research note available on request to the author. I will briefly summarize the results here.

1. IMPROVING UT1 BY MAPPING NUTATION

The IAU 2000A nutation model is not perfect. The nutation offsets contain a non negligible signal arising from unmodeled or mismodeled tidal terms or other geophysical contribution including the atmosphere and the free core nutation (FCN). An empirical modeling of the nutation can be achieved by (i) adjusting the FCN term, and (ii) fitting a number of tidal terms to the nutation offsets, like those listed in the Table 1 of Herring et al. (2002). The atmospheric contribution to the nutation remains unpredictable due to strong inconsistencies in the global circulation models at diurnal frequencies and will therefore not be considered here.

To test the efficiency of mapping nutation offsets, I run several solutions in which the nutation offsets are alternatively (i) unmapped (i.e., the nutation series are entirely given by the IAU 2000A model), or mapped by (ii) a variable FCN term plus 42 tidal waves. Efficiency of the solutions in terms of reproducing the length-of-day (LOD) as predicted by the combined NCEP and ECCO excitations are reported in Table where S is the rms of the difference to C04, and C the correlation coefficient between the geophysical LOD and the one derived from the estimated UT1. The improvement is about 0.07 % and 0.004 %, respectively for the averaged postfit rms delay and the correlation coefficient.

2. OVERPARAMETERIZATION OF INTENSIVE SOLUTIONS

Can I use an analysis configuration closer to the one used in the processing of multi-baseline diurnal VLBI sessions? Instead of estimating the ZTD as a constant offset over the full duration of the session, one can estimate it over shorter intervals, say 30 min or even 10 min, if the number of scans within the interval is sufficient. In addition, one can free the station positions and apply a loose constraint of $\sigma \sim 100$ m to tie them to the terrestrial reference frame and avoid degeneracy of the system of equations. I run a number of solutions to illustrate these options. In all the solutions below, the polar motion is mapped by the C04 series, but the nutation offsets are unmapped. Characteristics of the solutions and averaged postfit rms delay together with S, C, and length repeatability (LR) for Kokee–Wettzell (Kk–Wz) and Tsukuba–Wettzell (Ts–Wz) baselines are reported in Table . It appears that the postfit rms have values comparable to those obtained with routine VLBI experiments (i.e., of the order of 20 ps) when a

	Averaged postfit rms delay (ps)	S (mas)	C
(i)	38.133	0.12450	0.940564
(ii)	38.127	0.12447	0.940593

Table 1: Characteristics of the solutions comparing mappings of nutation offsets.

ZTD interval (min)	Station status	Average postfit rms delay (ps)	S (mas)	C	Kk–Wz LR (mm)	Ts–Wz LR (mm)
Full duration	Not estimated	38.134	0.12450	0.940564		
Full duration	Estimated	35.789	0.12453	0.940549	73	25
30 min	Not estimated	30.992	0.12444	0.940614		
30 min	Estimated	28.902	0.12452	0.940550	79	26
10 min	Not estimated	22.721	0.12428	0.940629		
10 min	Estimated	20.902	0.12451	0.940562	87	27

Table 2: Characteristics of the solutions.

maximum number of parameters including ZTD over 10-min intervals and site coordinates are estimated. However, the lowest rms is obtained when ZTD is estimated over 10-min intervals with fixed stations (as much as 40 % smaller than for S0). This solution also provides the highest correlation coefficient with the geophysical excitation, and, therefore, the UT1 closest to the reality. Again, the differences between the various strategies are of about 0.2 % for S and 0.007 % for C.

3. CONCLUSIONS

Using independent modeling and analyses and a different method to assess the quality of the UT1 estimates, I confirm the results of Malkin (2009, 2011). Mapping the nutation offsets by a simple model of variable FCN and a small number of tidal terms slightly improves the determination of UT1. The overparameterization of the solution, consisting of estimating station positions and/or troposphere zenith time delays over intervals of a few minutes, considerably reduces the postfit rms delay to values comparable to those obtained from the analysis of routine VLBI experiments. However, the quality of UT1 estimates is only marginally improved.

This study addresses the usefulness of providing an empirical model for the nutation offsets. Currently, the Chapter 5 of the IERS Conventions recommends a FCN model adjusted to the C04 data. Completing this model by the fit of a few tidal waves to the same data could be useful. Nevertheless, the improvement in UT1 estimates from intensive sessions will remain marginal.

4. REFERENCES

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