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Comparison of UT1 and Polar Motion from IVS Sessions Derived from VieVS and Solve Analysis

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Abstract

We compare UT1 and Polar Motion results obtained with Vienna VLBI Software (VieVS [1]) and Calc/Solve [2] from IVS sessions 2011. Results from both Intensive (INT) and 24-hour (R) sessions are compared. We discuss the formal errors of the estimates, as well as the agreement of the two sets of estimates with the C04 EOP time series. A total of 48 INT and 28 R sessions were included in the analysis.

1. Introduction

An important data product produced by VLBI analysis are the estimated Earth Orientation Parameters (EOP). VLBI is unique in its ability to measure UT1, and this is crucial in many scientific and technical applications including satellite navigation. Because of the importance of EOP in general, and UT1 in particular, it is important to understand the accuracy of the VLBI technique. In this paper we approach this problem by comparing EOP estimates from two software packages. The Calc/Solve analysis software [2] is widely used by the geodetic VLBI community. One of the newer programs is the Vienna VLBI Software (VieVS [1]). We compare the UT1 and polar motion results obtained by the software packages with their default configurations in order to compare the results produced by the software packages in their operational modes. We also compare the results from using the software packages in a new test configuration that synchronized the configuration settings as much as possible in order to compare the performances of the software packages themselves.

2. Configuration of the Programs

Both software packages have very flexible configurations, and the results from the packages depend on the selected configuration settings. First the programs were run with their regular settings for both Intensive and 24-hour sessions. After the default analysis, a new configuration was used where the VieVS and Solve configurations were chosen to be as close to each other as possible. For example, in the new configuration both programs used IAU 2000A for precession and nutation, JPL 405 for ephemerides, and VM1 as the mapping function. In the new setup VieVS and Solve both use IERS 05 C04 as the EOP a priori file. The modeling options for the default settings of the programs and the new configuration are listed in Figure 1. The models that could not be the same for both software are marked with light color.

Comparison of VieVS and Solve Solution Setup				
	Default configuration		New configuration	
	VieVS	Solve	VieVS	Solve
Solution type	Group delay only	Group delay only	Group delay only	Group delay only
Number of sessions	One standalone	Int: one standalone 24-hr: combined solution	One standalone	Int: one standalone 24-h: combined solution
Elevation cutoff	0 deg	5 deg	0 deg	0 deg
Ephemerides	JPL 421	JPL 405	JPL 405	JPL 405
A priori EOP	IERS C04	Int: USNO finals 24-h: file from operational solution	IERS C04	IERS C04
Precession/nutation	IAU 2000A	IAU 2006	IAU 2000A	IAU 2000A
TRF	VTRF2008	Files from operational solution	VTRF2008	VTRF2008A
CRF	ICRF2	Files from operational solution	ICRF2	ICRF2
DUT1 interval, constraint	Int: 60 min, 0.0001 ms/day 24-h: 30 min, 0.0001 ms/day	Int: One offset, no constraints 24-hr: One offset and one rate, 3 ms and ms/day	Int: 60 min, 0.01 ms/day 24-h: 30 min, 0.0001 ms/day	Int: One offset, no constraints 24-hr: one offset and one rate, 3 ms and ms/day
Polar motion interval, constraint	Int: not estimated 24-h: 30 min, 0.0001 ms/day	Int: not estimated 24-hr: one offset and one rate apiece for X and Y, 45 mas and mas/day	Int: not estimated 24-h: 30 min, 0.0001 ms/day	Int: not estimated 24-hr: one offset and one rate for X and Y, 45 mas and mas/day
ZWD interval, constraint	60 min, 0.0001 ps²/s 24-h: 30 min, 0.0001 ps²/s	Int: One offset, no constraints 24-h: 20 min, 50 ps/hour	Int: 60 min, 0.0001ps²/s, 24-h: 30 min, 0.01 ps²/s	Int: One offset, 36 ps/hour 24-h: 20 min, 36 ps/hour
Weighting	No	Baseline weights from operational solution	No	Baseline weights from operational solution
Clock interval, constraint	Int: 1440 min, no constraints 24-h: 60 min, 0.5 ps²/s	Int: second order polynomial, no spline, no constraints 24-h: 60 min, 5 fs	Int: 1440 min, no constraints 24-h: 60 min, 0.5 ps²/s	Int: second order polynomial, no spline, 7 fs 24-h: 60 min, 7 fs
Mapping function	VM1	Int: NMF 24-h: VM1	VM1	VM1

Figure 1. Comparison of VieVS and Solve solution setup.

In the case of Intensive sessions the epoch was chosen to be the half point of a session, and in the case of 24-hour sessions the midnight was chosen as the epoch.

3. Results

3.1. UT1 and Polar Motion

Figures 2 and 3 show dUT1 = UT1-UTC (in microseconds) from Intensive and 24-hour sessions relative to the to IERS 05 C04 values. The results from both the original setups of the two programs and the new setups are displayed. In Figures 4 and 5 Xpol and Ypol estimates from the 24-hour adjustment are shown.

3.2. RMS Values and Differences

Figure 6 displays the RMS values of the dUT1 estimates relative to their a priori values in the Intensive sessions and the dUT1, Xpol, and Ypol estimates relative to their respective a priori values in the 24-hour sessions. Also the RMS difference between the solutions is listed in Figure 6.

When VieVS and Solve were configured with the new setup, it worsened all the RMS values from VieVS. Also all the RMS results from Solve worsened, except the dUT1 value from the Intensives, which was slightly better than that from the default setup. It can be seen from Figure 6 that the RMS difference of dUT1 Intensive estimates improves with the new setup. Otherwise the RMS differences worsen in the case of 24-hour sessions and the new setup.

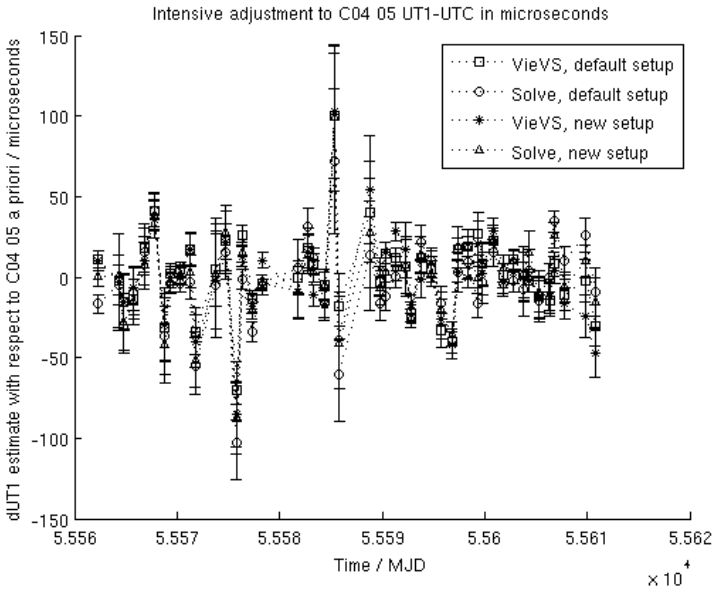

Figure 2. dUT1 estimate with respect to the a priori IERS 05 C04 calculated from IVS Intensive sessions with VieVS and Solve programs with default and new setups. The dates covered by the analysis are January 1st through February 17th, 2011.

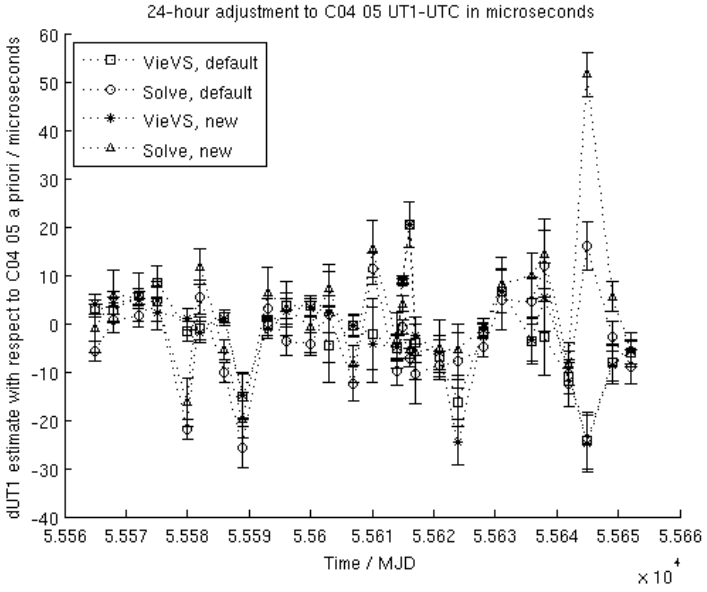

Figure 3. dUT1 estimate with respect to the a priori IERS 05 C04 calculated from IVS 24-hour sessions with VieVS and Solve programs with default and new setups. The dates covered by the analysis are January 3rd through March 31st, 2011.

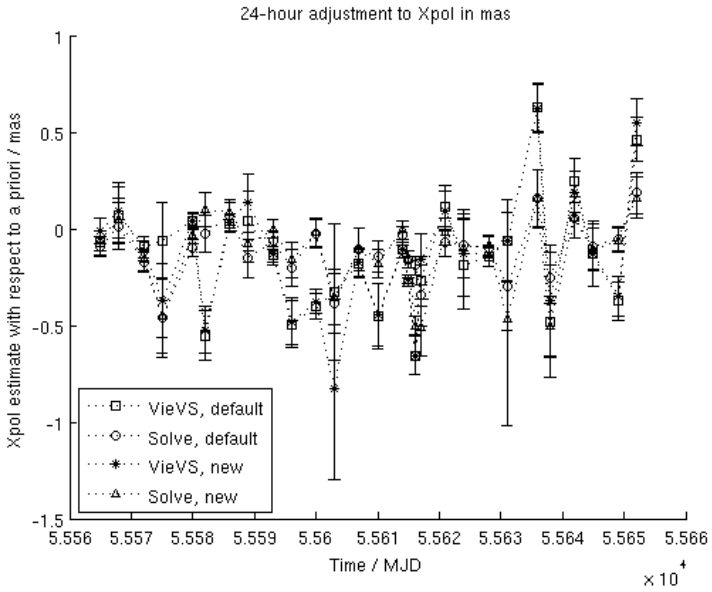

Figure 4. Xpol with respect to IERS 05 04 calculated from IVS 24-hour sessions with VieVS and Solve programs with default and new setups. The dates covered by the analysis are January 3rd through March 31st, 2011.

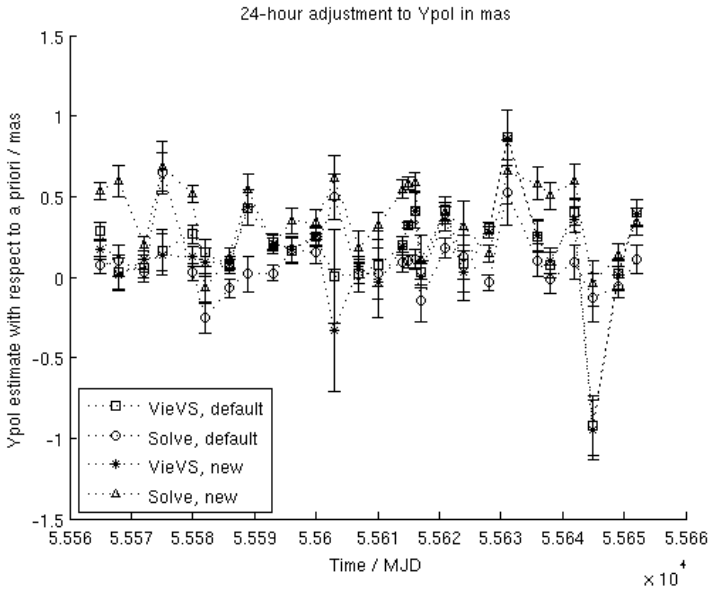

Figure 5. Ypol with respect to IERS 05 04 calculated from IVS 24-hour sessions with VieVS and Solve programs with default and new setups. The dates covered by the analysis are January 3rd through March 31st, 2011.

Comparison of VieVS and Solve RMS values				
	Default configuration		New configuration	
	VieVS	Solve	VieVS	Solve
RMS of dUT1 estimate (μs), intensive solution	25.56 +/- 13.99	27.44 +/- 15.48	27.90 +/- 15.70	26.67 +/- 15.49
RMS of dUT1 estimate (μs), 24-hour solution	8.73 +/- 4.01	9.94 +/- 3.79	9.25 +/- 4.15	12.85 +/- 4.67
RMS of Xpol estimate (mas), 24-hour solution	0.31 +/- 0.15	0.18 +/- 0.11	0.35 +/- 0.16	0.24 +/- 0.14
RMS of Ypol estimate (mas), 24-hour solution	0.33 +/- 0.11	0.20 +/- 0.10	0.33 +/- 0.12	0.44 +/- 0.10
RMS difference of dUT1 estimates (μs), intensive solution	17.51 +/- 4.08		12.68 +/- 3.24	
RMS difference of dUT1 estimates (μs), 24-hour solution	12.32 +/- 1.48		17.40 +/- 2.34	
RMS difference of Xpol estimates (mas), 24-hour solution	0.25 +/- 0.058		0.25 +/- 0.098	
RMS difference of Ypol estimates (mas), 24-hour solution	0.29 +/- 0.045		0.35 +/- 0.058	

Figure 6. RMS values and differences for dUT1 and polar motion estimates relative to the a priori EOPs for different configurations of VieVS and Solve.

4. Conclusions

As can be seen from Figure 6, almost all of the RMS values worsen for both programs when using the new configuration. When looking at the RMS difference between the two programs, it can also be noticed that they are only improved with the new configuration for the Intensive solution. More work is needed to make the 24-hr solution RMS difference smaller, and to bring the configurations of VieVS and Solve closer to each other.

On the basis of this analysis it seems that VieVS gives smaller RMS values for UT1, and Solve for polar motion when using the default configurations of the two programs. To ensure this result the amount of sessions should be increased from the 48 Intensive and the 28 24-hour sessions used here, to about ten times larger amount. It also would be interesting to compare the results to those obtained by another technique, like GNSS.

Acknowledgements

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References

[1] Böhm, J, S. Böhm, T. Nilsson, A. Pany, L. Plank, H. Spicakova, K. Teke, H. Schuh. The new Vienna VLBI Software VieVS, in Proceedings of IAG Scientific Assembly 2009, In: International Association of Geodesy Symposia Series Vol. 136, edited by S. Kenyon, M. C. Pacino, and U. Marti, pp 1007-1011, 2012, doi: $10.1007/978-3-642-20338-1\_126$.

[2] http://gemini.gsfc.nasa.gov/solve/