Using External Tropospheric Delay in VLBI Data Processing

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Abstract The zenith wet tropospheric delay is one of the parameters that need to be estimated in routine VLBI data processing. Stations of the Russian national VLBI network "Quasar-KVO" will be equipped with water vapor radiometers in the next year, and we performed several experiments in order to estimate how the external tropospheric data can improve the accuracy of VLBI astrometry results. We process hourly UTC–UT1 estimation sessions using VLBI and GPS estimated tropospheric delays. In the first case, one can see potential improvement from external tropospheric data in the UTC–UT1 formal errors. The second case shows that, when we use truly external data from GPS, the results can be improved.

Keywords VLBI, troposphere, WVR

1 Introduction

The tropospheric delay can be divided into "dry" and "wet" components. The "dry" component can be calculated using the Saastamoinen formula from the atmospheric pressure. In routine VLBI data processing, we estimated only Wet Zenith Delay (WZD) and gradients. It can be assumed that using a priori tropospheric data (from GNSS or WVR) can improve EOP and coordinate results. We expect maximum effect for the hourly UT1–UTC sessions.

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2 Simulation

We performed simulations in order to estimate the maximum possible improvement from external tropospheric delays. Hourly one-baseline sessions from the Ru-U program (31 sessions from 14.09.2012 to 14.10.2012, Zelenchukskaya–Badary) were processed with the QUASAR software:

1. No a priori WZD, estimated parameters: UT1–UTC; linear clock + stochastic; WZD + stochastic.
2. A priori WZD from solution 1, estimated parameters: UT1–UTC; linear clock + stochastic; WZD + stochastic.
3. A priori WZD from solution 1, estimated parameters: UT1–UTC; linear clock + stochastic; No WZD.

We obtained for the first solution a UT1–UTC mean formal error of 41 μs, for the second solution 29 μs, and for the third solution 19 μs. Thus, the maximum improvement can be up to two times if the external tropospheric delay is set to a VLBI estimate.

3 GPS Tropospheric Delay in VLBI Processing

We processed VLBI data with tropospheric delays taken from GNSS data. We took sessions of the Ru-U program from 2012.11.01 to 2013.01.27, 60 hourly one-baseline Zelenchukskaya–Badary sessions. The tropospheric delay data came from the JPL GPS products database. Only total zenith delays (TZD) are available from GPS. The WZD was obtained using the Saastamoinen formula. Five solutions were obtained:

1. Standard solution, no stochastic, no a priori troposphere: Est: (+clock,+dUT1,+WZD), Apr: -TZD, -WZD
2. Standard solution, +stochastic, no a priori troposphere: Est: (+clock,+dUT1,+WZD+random), Apr: -TZD, -WZD
3. Estimation only clock and UT1-UTC; a priori WZD and TZD from GPS: Est: (+clock,+dUT1), Apr: +TZD, +WZD (GPS)
4. Estimation only clock and UT1-UTC; a priori WZD from GPS: Est: (+clock,+dUT1), Apr: -TZD, +WZD (GPS)
5. Estimation only clock and UT1-UTC; a priori WZD from GPS; station positions from QUASAR global solution (2011): Est: (+clock,+dUT1), Apr: -TZD, +WZD (GPS)

Table 1 Differences of the Ru-U UT1 estimations to the IERS series, μs.

Solution ID	RMS	WRMS	Mean formal error, μs	TRF
1	49	41	38	ITRF2008/Q2011
2	48	42	42	ITRF2008
3	44	41	34	ITRF2008
4	48	46	39	ITRF2008
5	41	36	33	Q2011

4 Conclusion

Real external tropospheric data can improve Intensive UT1–UTC results up to 20%. Station coordinates are crucial, because the WZD parameter in one-baseline sessions takes on station coordinate errors. We obtain the best improvement from the GPS troposphere when using more correct station coordinates. Our plans are to obtain new results after WVRs are installed at all QUASAR network stations.