GPS frequency transfer with IPPP

Petit G.[1], Kanj A.[1,3], Harmegnies A.[1], Loyer S.[2], Delporte J.[3], Mercier F.[3], Perosanz F.[3]

[1] Time Department, BIPM, 92312 Sèvres, France
[2] CLS, 31520 Ramonville Saint Agne, France
[3] CNES, 31401 Toulouse, France

Email: gpetit@bipm.org

Since many years, the BIPM has been using the Precise Point Positioning (PPP) technique using GPS phase and code observations to compute time and frequency links. The technique has been used operationally to compute time links for International Atomic Time TAI since September 2009 and now concerns over 50% of the more than 70 laboratories contributing to TAI and UTC. The technique provides very good short term stability due to the low phase noise and to the precise satellite orbits and clock products generated by the International GNSS Service (IGS), however it is limited in accuracy to about the same level as code-only techniques. We therefore concentrate on the performances in terms of frequency transfer.

The BIPM operationally uses the GPSPPP software from Natural Resources Canada, which provides continuous processing of phase data for up to one month, using the determination of floating values phase ambiguities. The long-term time stability of the TAI links is essential to provide the lowest possible uncertainty when comparing primary and secondary frequency standards, which frequency accuracies are now in the low 10^{-16} and are continuously improving. We estimate the present uncertainty of our PPP frequency comparisons over 15-30 days to be also in the low 10^{-16}, i.e. it is a strong limiting factor in comparing primary frequency standards.

One main limiting factor of PPP with floating ambiguities comes from the effect on the clock solution of the simultaneous resolution of floating phase ambiguities together with other parameters such as the tropospheric delay and station position. In this paper we study how to improve the frequency transfer using the Integer-PPP (IPPP) technique implemented by the CNES.

IPPP is based on the resolution of the phase data integer ambiguities at the un-differenced level and needs precise GPS satellite orbit and clock products with a priori knowledge of individual satellite fractional-cycle biases as derived by the CNES-CLS IGS Analysis Center. We expect IPPP to provide a continuous and rigorous treatment for ambiguity resolution over any interval under study rather than concatenating results obtained over shorter intervals when using floating ambiguities.

We use IPPP and conventional PPP to compute links between three laboratories operating atomic fountains and study how the different results succeed in attaining the expected long-term frequency stability of the fountains. Preliminary results indicate an improvement in stability with the IPPP approach. Several problems need to be addressed in view of a more “operational” use of IPPP and will be reviewed.