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Usage of SIRGAS-CON solutions as a support to the investigations about PPP-RTK in the Brazilian region.

Thomas Felipe de Lima - thomasfelipedelima@gmail.com; Isabela Martin Silva – iam.isamartin@gmail.com;
Paulo Sérgio de Oliveira Jr. paulo.junior@ufpr.br; João Francisco Galera Monico – galera.monico@unesp.br

1. Context and Objectives

GNSS provides real time positioning and navigation, with centimeter accuracy. One of the positioning methods via GNSS that has been currently standing out in the recent literature is PPP-RTK (Precise Point Positioning – Real Time Kinematic), which is the PPP with ambiguity fixing in real time. However, PPP-RTK solution usually requires a certain time (approximately 30min.) in order to achieve acceptable ambiguity resolution, thus centimetric accuracy. The necessary amount of time for the convergence of the PPP-RTK is caused by several systematic errors, among them the ionosphere and troposphere effects. Such effects need to be properly estimated or modeled, making real time positioning a challenge. This research aims to assess and analyze PPP-RTK results obtained by applying ionospheric and tropospheric corrections generated through stations of RBMC (Brazilian Continuously Operating Network) stations in Brazil. Reference ground truth coordinates used to validate PPP-RTK solutions are obtained through SIRGAS-CON (post-processed). SIRGAS-CON consists of weekly regional network positioning solutions for a stations set of SIRGAS network. Thanks to SIRGAS-CON products it is possible to assess GNSS processing quality with no velocity models, since the estimated coordinates to SIRGAS-CON stations are already compatible with the respective surveying epoch.

2. Methodology

In this experiment we selected four RBMC stations available, which belong to the RBMC-IP network (Figure 1). These stations were chosen because GNSS observations are stored with 1 second sampling data interval, enabling real time simulation. 03 stations are settled ass rover (user) simulated station and stations around are employed to generate ionospheric and tropospheric corrections (Figure 02). The general strategy for generating and applying the ionospheric corrections are shown in Figure 3.

Figure 1: SIRGAS continuously operating of the Brazilian network cartogram
Source: ibge.gov.br

Figure 2: Possible geometry for generation and application of atmospheric corrections

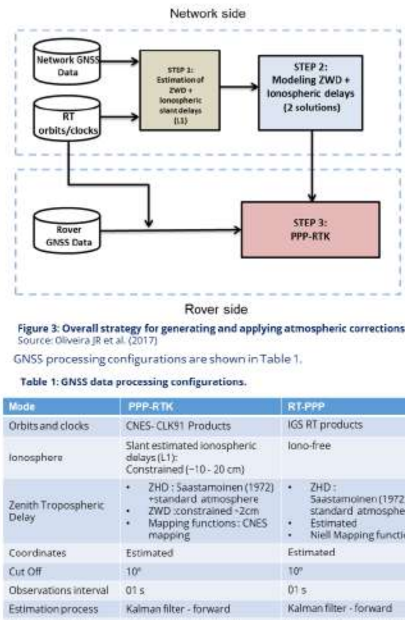

Figure 3: Overall strategy for generating and applying atmospheric corrections.
Source: Oliveira JR et al. (2017)

GNSS processing configurations are shown in Table 1.

Table 1: GNSS data processing configurations.

Mode	PPP-RTK	RT-PPP
Orbits and clocks	CNES- CLK91 Products	IGS RT products
Ionosphere	Slant estimated ionospheric delays (L1): Constrained (~10 - 20 cm)	Iono-free
Zenith Tropospheric Delay	• ZHD : Saastamoinen (1972) +standard atmosphere • ZWD :constrained ~2cm • Mapping functions : CNES mapping	• ZHD : Saastamoinen (1972) + standard atmosphere • Estimated • Niell Mapping function
Coordinates	Estimated	Estimated
Cut Off	10°	10°
Observations interval	01 s	01 s
Estimation process	Kalman filter - forward	Kalman filter - forward
Other parameters	IERS Conventions (2010)	IERS Conventions (2010)
Software	PPP-Wizard 1.4(Laurichesse andPrivat, 2015)	RTKLib. 2.4.3 beta (Takasu, 2013)

3. Results and Analysis

Figure 4, 5 and 6, present PPP-RTK performances compared to Real Time PPP (float solution) at stations UFPR, POLI and BRAZ, respectively. For stations UFPR and POLI, PPP-RTK solution presented an improved convergence, achieving planimetric discrepancies better than 10 cm in ~5min. However, at station BRAZ PPP-RTK showed problems after ~ 74min convergence, probably thanks to cycle slip followed by mismodeling of atmospheric effects.

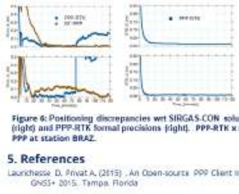

Figure 4: Positioning discrepancies wrt SIRGAS-CON solutions (right) and PPP-RTK formal precisions (right). PPP-RTK x RT-PPP at station UFPR.

Figure 5: Positioning discrepancies wrt SIRGAS-CON solutions (right) and PPP-RTK formal precisions (right). PPP-RTK x RT-PPP at station POLI.

Figure 6: Positioning discrepancies wrt SIRGAS-CON solutions (right) and PPP-RTK formal precisions (right). PPP-RTK x RT-PPP at station BRAZ.

4. Final Considerations

This contribution presented preliminary results in Brazil region achieved with PPP-RTK. Improvements with respect to classical RT-PPP solutions were observed. Although investigations on cycle slips mitigation as well as improvements on atmospheric corrections considering the very long baselines used to interpolate/model atmospheric corrections. For the next steps of this research, investigations on L1 positioning, as well as statistical validation are aimed.

5. References

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