Using the IGS Real-Time Service and G-Nut/Tefnut for Nowcasting Severe Weather

Introduction

Today, GNSS meteorology relies on the assimilation of GPS-based hourly-updated Zenith Tropospheric Delays (ZTDs) for Numerical Weather Prediction (NWP). Neither information about the atmospheric heterogeneities (e.g., horizontal gradients) nor multi-GNSS observations are used operationally. Compared to current operational GPS meteorology (NWP), monitoring and forecasting severe weather (nowcasting) requires (4):

1) Higher spatial and temporal resolutions,
2) Information about the asymmetry in the atmosphere and
3) Provision of this information with almost no latency (optimally less than 5 min).

This requires a complete real-time approach, from the acquisition of the GNSS observations, orbits and clocks up to the generation of the tropospheric products and their delivery. Such applications can now be investigated thanks to:

1) The IGS Real-Time Service (started in April 2013) and
2) The ongoing developments of GNSS processing software capable of estimating tropospheric products in real-time.

G-Nut/Tefnut (1) is one of these real-time GNSS software and is developed at the Geodetic Observatory Pecny (G), Czech Republic. The Royal Observatory of Belgium (ROB) and GFZ are investigating the use of G-Nut/Tefnut for the exploitation of the official GNSS network to provide tropospheric products in real-time for nowcasting applications, focusing on the asymmetry and multi-GNSS aspects.

This poster presents the developments and first results from this new collaboration.

1D Atmospheric Parameter – Zenith tropospheric Total Delays (ZTD)

Figure 2: ZTD differences between the estimates produced by G-Nut/Tefnut and the IGS Final troposphere products for the 23 IGS stations. Top: East–West differences, bottom: North–South differences.

Figure 3: Histogram of the ZTD differences between the estimates produced by G-Nut/Tefnut and the IGS Final troposphere products for the 23 IGS stations.

Figure 4: Histogram of the ZTD differences between the estimates produced by G-Nut/Tefnut and the ROB PPP troposphere products for the 23 IGS stations.

Figure 5: Histogram of the ZTD differences between the estimates produced by G-Nut/Tefnut and the IGS Final troposphere products for the 23 IGS stations.

BENCHMARK CAMPAIGN

Figure 1 shows the network of permanent stations selected to benchmark our developments. It includes 23 European IGS stations (top) and the 67 stations from the Belgian dense network (bottom). Most of the stations are tracking both GPS and GLONASS signals (green dots). The analysis period covers January-April 2014. The processing strategy is summarised in Table 1. The results are compared to two reference datasets: 1) the IGS Final troposphere Product (3) and 2) a Bernese (2) PPP solution ran at ROB. Both estimate tropospheric parameters with a time resolution of 5 min (with a similar strategy as in Table 1).

2D Atmospheric Asymmetries – Horizontal Gradients (GRD)

Figure 6: Histogram of the gradient differences between the estimates produced by G-Nut/Tefnut and the IGS Final troposphere products for the 23 IGS stations.

Figure 7: Histogram of the gradient differences between the estimates produced by G-Nut/Tefnut and the ROB PPP troposphere products for the 23 IGS stations.

Figure 8: Histogram of the gradient differences between the estimates produced by G-Nut/Tefnut and the IGS Final troposphere products for the 23 IGS stations.

Figure 9: Histogram of the gradient differences between the estimates produced by G-Nut/Tefnut and the ROB PPP troposphere products for the 23 IGS stations.

On-going & Future Investigations

• Setup a real-time benchmark campaign and carry out a long-term evaluation based on the IGS realtime service to confirm the results obtained above in operational conditions.
• Extend the test period from January 2012 – now.
• Investigate the added-value of multi-GNSS observations in G-Nut/Tefnut for nowcasting.
• Further investigate the backward smoothing of the troposphere parameter estimates.