Geophysical Research Abstracts, Vol. 9, 04389, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04389

Medium Scale Travelling Ionospheric Disturbances: Detection, modelling and application to precise GNSS navigation

M. Hernández-Pajares, J.M. Juan and J. Sanz
gAGE/UPC, Research group of Astronomy and Geomatics, Technical University of Catalonia, Barcelona, Spain (manuel@ma4.upc.edu , mhpajares@gmail.com / Fax: +34 934015981)

The main objective of this presentation is to show how a simple ionospheric disturbance model (deduced by the authors from a previous study based on several worldwide local GPS networks) can significantly help to improve the performance of precise real-time positioning techniques, such as RTK, WARTK based on GPS, or TCAR and WARTK-3 based on future Galileo and GPS-III systems, among others.

Indeed, the feasibility of real time GNSS navigation, at distances greater than few tens of kilometers from a reference site, is strongly related to the capability of providing accurate differential ionospheric refraction values to the user, in real-time. If such provided differential STEC values are very accurate (better than 0.25 TECU, about 4.5 cm in L1), then the user has the chance of fast carrier phase ambiguity fixing thanks to this additional datum (this fixing can be near instantaneous with Galileo and modernized GPS systems). In this way the corresponding real-time positioning capability with errors below 10 cm can be attained, as it was demonstrated for instance in Hernández-Pajares et al. (2004), in a difficult scenario including baselines greater than 100 km (Wide Area Real Time Kinematic technique, WARTK). One of the main typical sources which difficult such task is the so called Medium Scale Traveling Ionospheric Disturbances (MSTIDs), wave-like signatures appearing in the ionospheric delay with typical amplitudes up to several TECUs (few tens of centimeters in L1) and wavelengths of 100-300 km. The MSTIDs show a strong seasonal behavior (which seems related to Solar Terminator and associated Atmospheric Gravity Waves), in such a way that they happens mostly on day-time in winter season, moving towards the equator with typical horizontal velocity of $\sim$100-250 m/s, and happen mostly on night-time in summer season moving westward with velocities of ∼50-150 m/s (see Hernández-Pajares et al, 2006a). This behavior makes feasible a simple MSTID modeling for practical applications such as the above mentioned precise GNSS navigation.

In this context we show that a significant increase of precision can be achieved by means of a simple real-time modeling of the MSTIDs, which takes advantage of its previously studied spatial and temporal characteristics. In particular the user ionospheric interpolation error can be reduced up to more than 50%, coinciding with the periods of higher MSTID activity (noon time in the case of the analyzed dataset in winter), in such a way that the sub-decimeter error-level navigation service area with WARTK is approximately twice compared with not using such MSTID modeling technique (more than 40% of daily increase in maximum baselines, from about 170 to ∼250 km of maximum distance to the nearest GNSS reference site, see Hernández-Pajares et al. 2006b for details).

References:

Hernández-Pajares M., J.M. Juan, J.Sanz, A.García-Rodríguez, O.L. Colombo, Wide Area Real Time Kinematic with Galileo and GPS Signals, awarded Oral presentation, ION-GNSS'2004, Proceedings, Long Beach, CA, USA, Sep. 2004.

Hernández-Pajares M., J.M. Juan, J. Sanz, "Medium scale Traveling Ionospheric Disturbances affecting GPS measurements: Spatial and Temporal analysis", JGR-Space Physics, VOL. 111, A07S11, doi:10.1029/2005JA011474, 2006a.

Hernández-Pajares M., J.M. Juan, J. Sanz, Real time MSTIDs modelling and application to improve the precise GPS and GALILEO navigation, Oral presentation, ION-GNSS'2006, Proceedings, Fort Worth, TX, USA, Sep. 2006b.