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Fast-PPP assessment in European and equatorial region near the solar cycle maximum

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The Fast Precise Point Positioning (Fast-PPP) is a technique to provide quick high-accuracy navigation with ambiguity fixing capability, thanks to an accurate modelling of the ionosphere. Indeed, once the availability of real-time precise satellite orbits and clocks is granted to users, the next challenge is the accuracy of real-time ionospheric corrections.

Several steps had been taken by gAGE/UPC to develop such global system for precise navigation. First Wide-Area Real-Time Kinematics (WARTK) feasibility studies enabled precise relative continental navigation using a few tens of reference stations. Later multi-frequency and multi-constellation assessments in different ionospheric scenarios, including maximum solar-cycle conditions, were focussed on user-domain performance. Recently, a mature evolution of the technique consists on a dual service scheme; a global Precise Point Positioning (PPP) service, together with a continental enhancement to shorten convergence.

A end to end performance assessment of the Fast-PPP technique is presented in this work, focussed in Europe and in the equatorial region of South East Asia (SEA), both near the solar cycle maximum. The accuracy of the Central Processing Facility (CPF) real-time precise satellite orbits and clocks is respectively, 4 centimetres and 0.2 nanoseconds, in line with the accuracy of the International GNSS Service (IGS) analysis centres. This global PPP service is enhanced by the Fast-PPP by adding the capability of global undifferenced ambiguity fixing thanks to the fractional part of the ambiguities determination.

The core of the Fast-PPP is the capability to compute real-time ionospheric determinations with accuracies at the level or better than 1 Total Electron Content Unit (TECU), improving the widely-accepted Global Ionospheric Maps (GIM), with declared accuracies of 2-8 TECU. This large improvement in the modelling accuracy is achieved thanks to a two-layer description of the ionosphere combined with the carrier-phase ambiguity fixing performed in the Fast-PPP CPF.

The Fast-PPP user domain positioning takes benefit of such precise ionospheric modelling. Convergence time of dual-frequency classic PPP solutions is reduced from the best part of an hour to 5-10 minutes not only in European mid-latitudes but also in the much more challenging equatorial region. The improvement of ionospheric modelling is directly translated into the accuracy of single-frequency mass-market users, achieving 2-3 decimetres of error after any cold start. Since all Fast-PPP corrections are broadcast together with their confidence level (sigma), such high-accuracy navigation is protected with safety integrity bounds.