



Real-time Precise Point Positioning with Ambiguity Resolution for Geosciences

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Real-time provision of information on large scale crustal deformation during an earthquake can be crucial in assessing property damage and managing relief operations. Moreover, such a real-time monitoring system may even lead to the accurate prediction of earthquakes in future and help the subsequent studies on the mechanism involved. During the past two decades, Global Positioning System (GPS) measurements have been extensively applied to investigate such processes in the geosciences.

Precise point positioning (PPP) using GPS based on single stations can achieve comparable accuracies to conventional relative positioning, when precise satellite orbits and clocks, and Earth rotation products are used. Thus, PPP does not need any reference stations to achieve high positioning accuracy, e.g. at the millimetre level in static and centimetre level in kinematic applications. This has both technical and economic advantages and may be the only feasible option in some specific applications such as Tsunami early warning systems.

However, unlike relative positioning, PPP suffers from unresolved integer ambiguities, which prevented further accuracy improvements within short observation periods or in real-time. On account of the great potential of PPP, we developed a prototype real-time PPP system which also employs ambiguity resolution at a single station. This development is based on the PANDA (Positioning And Navigation Data Analyst) software, which was originally developed at Wuhan University in China, and has been significantly refined by the authors.

To assess this system, about 30 stations from the EUREF Permanent Network Internet Protocol (EUREF-IP) pilot project are used to produce the real-time satellite clocks, with satellite orbits and Earth rotation parameters (ERP) fixed to the predicted part of the IGS (International GNSS Service) ultra-rapid products. This is followed by the estimation of the uncalibrated hardware delays (UHD), which are crucial in resolving the ambiguities. Finally, all products (clocks, orbits, UHDs and ERPs) are provided in real-time to allow PPP with ambiguity resolution. Through the simulation of this prototype real-time PPP system, we show that significant accuracy improvements can be achieved, which are of significance to real-time applications in the geosciences.