The development and application of PPP technology with multi-constellation GNSS

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Precise point positioning (PPP) was introduced in 1990s as an efficient and robust analysis technique for data provided by global navigation satellite system (GNSS) receivers on the ground. PPP can estimate a single receiver position without generating a baseline by fixing orbits and clocks of GNSS satellites to previously determined precise values. PPP can continuously support many users distributed in world-wide without any reference station.
In data processing in PPP, ionospheric effect is usually eliminated by dual-frequency GNSS signals. Tropospheric term is also estimated as an unknown parameter of zenith total delay (ZTD) with an appropriate mapping function. The ZTD can bee easily translated to precipitable water vapor (PWV) at the site. GNSS meteorology has consequently been a popular application of PPP.
For the precise satellite orbits and clocks for PPP, International GNSS Service (IGS) has been make great contributions to develop models, algorithms and products since 1990s. Recently IGS has started to provide real-time products in addition to conventional post-processing ones.
In 2011, Japan Aerospace Exploration Agency (JAXA) started to develop a new suite of software to provide precise orbits and clocks of GNSS satellites called MADOCA (multi-GNSS advanced demonstration tool for orbit and clock analysis). MADOCA intends to support all of multi-GNSS-constellation, including GPS, GLONASS, QZSS, Galileo and BeiDou, both for post-processing and real-time mode. For a client of MADOCA-PPP, an extension of RTKLIB, which was a popular open-source GNSS data analysis software developed by the author, is used including ambiguity resolution (AR) feature.
The lecture summarizes development, implementation, evaluation, application and future of MADOCA and RTKLIB.

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