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Modeling Tropospheric Wet Delays and Research of its Contribution on the Real-time GNSS Precise Point Positioning

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Precise Point Positioning (PPP) is a well-known technique of positioning at a global scale which can be adopted in many applications. However, the convergence time is too long and limits the development of PPP, especially in real-time applications. By introducing some external corrections such as ionospheric, tropospheric corrections, the convergence time is always expected to be reduced. In this contribution, several methods for modeling of tropospheric wet delays in wide-area are investigated and a desirable model is determined for real-time PPP. Based on the GPT2 model, a modified parameter of zenith wet delay (ZWD) exponential decay is introduced in the modeling of real-time tropospheric delay, which can obtain the same accuracy comparing with the method based on water vapor scale height. Furthermore, this model can accurately model the real-time tropospheric delays up to 10km altitude, which potentially benefits in many applications. The Root Mean Square (RMS) of the zenith troposphere delay (ZTD) is about 1.2cm on average with cross-validation in four seasons. By augmentation of the real-time ZTD model, the BDS/GNSS PPP convergence performance is evaluated. It is shown that the ZTD model can greatly reduce the convergence time for BDS PPP, especially in the vertical direction. Comparing with the standard real-time PPP, the convergence time reduce from 20% to 50% and 2% to 7% for the augmentation PPP in the vertical and horizontal directions, respectively. The improvement for GPS PPP convergence time is about 6% and 18% on average in the horizontal and vertical directions, respectively. When combined GPS and BDS, the differences between the augmentation PPP and the standard PPP with blind model is very small. It is concluded that the contribution of the real-time ZTD model will be insignificant on the multi-GNSS PPP, as the satellite geometry is good enough to get a reliable PPP solution.