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ORIGINAL ARTICLE

A preliminary evaluation of the performance of multiple ionospheric models in low- and mid-latitude regions of China in 2010–2011

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Abstract Ionospheric delay is a dominant error source in Global Navigation Satellite System (GNSS). Single-frequency GNSS applications require ionospheric correction of signal delay caused by the charged particles in the earth's ionosphere. The Chinese Beidou system is developing its own ionospheric model for single-frequency users. The number of single-frequency GNSS users and applications is expected to grow fast in the next years in China. Thus, developing an appropriate ionospheric model is crucially important for the Chinese Beidou system and worldwide single-frequency Beidou users. We study the performance of five globally accessible ionospheric models Global Ionospheric Map (GIM), International Reference Ionosphere (IRI), Parameterized Ionospheric Model (PIM), Klobuchar and NeQuick in low- and mid-latitude regions of China under mid-solar activity condition. Generally, all ionospheric models can reproduce the trend of diurnal ionosphere variations. It is found that all the models have better performances in mid-latitude than in low-latitude regions. When all the models are compared to the observed total electron content (TEC) data derived from GIM model, the IRI model (2012 version) has the best agreement with GIM model and the NeQuick has the poorest agreement. The RMS errors of the IRI model using the GIM TEC as reference truth are about 3.0–10.0 TECU in low-latitude regions and 3.0–8.0 TECU in mid-latitude regions, as observed during a period of 1 year with medium level of solar activity. When all the ionospheric models are ingested into single-frequency precise point positioning (PPP) to correct the ionospheric delays in GPS observations, the PIM model performs the best in both low and mid-latitudes in China. In mid-latitude, the daily single-frequency PPP accuracy using PIM model is $\sim$10 cm in horizontal and $\sim$20 cm in up direction. At low-latitude regions, the PPP error using PIM model is 10–20 cm in north, 30–40 cm in east and $\sim$60 cm in up component. The single-frequency PPP solutions indicate that NeQuick model has the lowest accuracy among all the models in both low- and mid-latitude regions of China. This study suggests that the PIM model may be considered for single-frequency GNSS users in China to achieve a good positioning accuracy in both low- and mid-latitude regions.

Keywords Ionospheric model · Precise point positioning (PPP) · Ionospheric model evaluation · Low- and mid-latitude regions of China

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Introduction

The range error resulting from the ionospheric delay can be up to 100 m in magnitude and can significantly affect the accuracy of the positioning, navigation, velocity and timing. The ionospheric delay of dual-frequency Global Navigation Satellite System (GNSS) users can be precisely corrected by measurements from dual-frequency signals.

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