The Performance and Clock Error Prediction Analysis of BDS Satellite Clock: A Comparison between BDS-2 and BDS-3

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ABSTRACT

To study the performance of BDS satellite atomic clocks and the accuracy of satellite clock error prediction, and to compare the difference between BeiDou Regional Navigation Satellite System (BDS-2) and BeiDou Global Navigation Satellite System (BDS-3). On the basis of analyzing the noise, frequency drift and frequency stability of satellite atomic clocks with a time span of one year from June 2023 to May 2024, three clock error prediction models, namely quadratic polynomial (QP), grey model (GM), and autoregressive integrated moving average (ARIMA), were selected to fit and predict based on the data of 7 days. Compared with BDS-2, BDS-3 atomic clocks have a lower noise level, with the average annual noise levels of BDS clocks being less than 1 ns. Similarly, the BDS-3 atomic clocks have a better satellite clock frequency drift, with the annual frequency drifts of the BDS clocks are at the level of 10^{-19}. In contrast to BDS-2, BDS-3 atomic clocks have higher frequency stability. Specifically, the ten thousand seconds stability of BDS clocks are at the level of 10^{-14}. The prediction accuracy of BDS-3 hydrogen clock, and BDS-3 new rubidium clock have been significantly improved in comparison with the BDS-2 rubidium clock. Moreover, the prediction accuracy of BDS-3 hydrogen clock at 3 h, 6 h and 12 h can respectively reach 0.19 ns, 0.26 ns and 0.33 ns. For BDS satellite clock error, ARIMA has the highest prediction accuracy and prediction stability, the prediction accuracy and prediction stability of GM are better than that of QP. By this study, we can understand the performance and the clock error prediction accuracy of BDS satellite clock, the difference between BDS-2 and BDS-3, and provide useful references for modeling and refining the BDS satellite clock error.

Keywords: BDS-2, BDS-3, performance, prediction