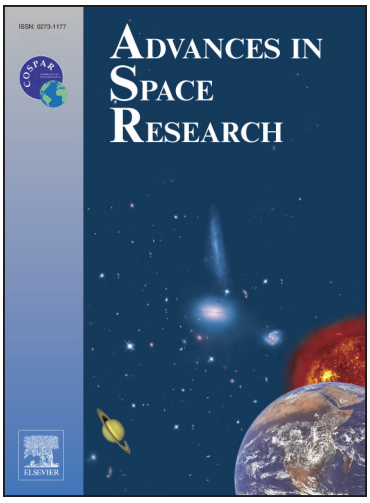

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Modeling of the GPS satellite clock error and its performance evaluation in precise point positioning

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Abstract The different functions, which include the polynomial and the harmonics based functions, are used to model and extrapolate the GPS satellite clock for simplifying the service mode and real-time application. The modeling accuracy decreases with the increasing modeled time, when the polynomial functions are used. The 4th order harmonics based function is used to model the one-year single day satellite clocks. The results indicate that the accuracies of the modeled Rb clocks are better than 0.30 ns, while that of the Cs clocks just are better than 0.79 ns. Meanwhile, we noticed that the daily fitted amplitudes for 16 Block IIF and Block IIR-M Rb clocks vary regularly with a 6 months periodicity. This is mostly visible for the harmonics of 6 and 12 h periods. However the initial phases of these 12 and 6 h harmonics have obvious linear variation for the 16 Block IIF and Block IIR-M Rb clocks. Additional periods of 8 h, 4.8 h, 3.43 h and 2.67 h are noticed by analyzing the modeling residuals of 4th order harmonics based function. The modeling of 8th order harmonics based function is implemented and the modeled accuracy is improved. The extrapolated results of the 4th and 8th order harmonics based functions are better than that of the broadcast ephemerides and the predicted parts of International GNSS Service (IGS) Ultra-Rapid (IGU) products. The performances of the modeled clocks in precise point positioning (PPP) show that the results of 4th and 8th order harmonics based functions reach centimeter level although their convergence times are slower than that of the IGS clock series product.

Keywords: Precise Point Positioning (PPP); Satellite clock modeling; GPS satellite clock

1 Introduction

Atomic clock loaded in navigation satellites is one of the core parts of the navigation system, which largely decides the high-precision time and frequency, hence becomes the basis and premise of global navigation satellite systems (GNSS) to achieve precise positioning. Although these clocks are highly