

# BeiDou/GPS real-time satellite clocks generation based on connection of hourly observation files

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## Introduction

With the development of GNSS system, there are lots of applications that require precise real-time satellites orbit and clock product.

For BeiDou, few analysis center provide precise BeiDou real-time satellite clocks. BeiDou broadcast ephemerides cannot be used for certain real-time processing because of the poor precision. For GPS, IGU-P, broadcast ephemerides cannot meet the need of certain applications either because of the poor precision. IGS RTS can supply real-time products with high accurate, but the data stream acquisition heavily depends on network.

At present, BeiDou/GPS real-time clocks are estimated using real-time observation data stream, transmission of which is heavily affected by the quality of internet too.

For some specific users, especially when they do not have very good communication condition and can not accept the real-time data or product, such as marine users, real-time clocks based on real-time data stream is not practical.

This works aims to supply an alternative choice for some specific users who can not receive real-time data well because of the network.

## Method

The algorithm mainly has 2 parts, as shown in Figure 1.

- Clock estimation based on arc observation data
- Ultra-short term clock prediction,

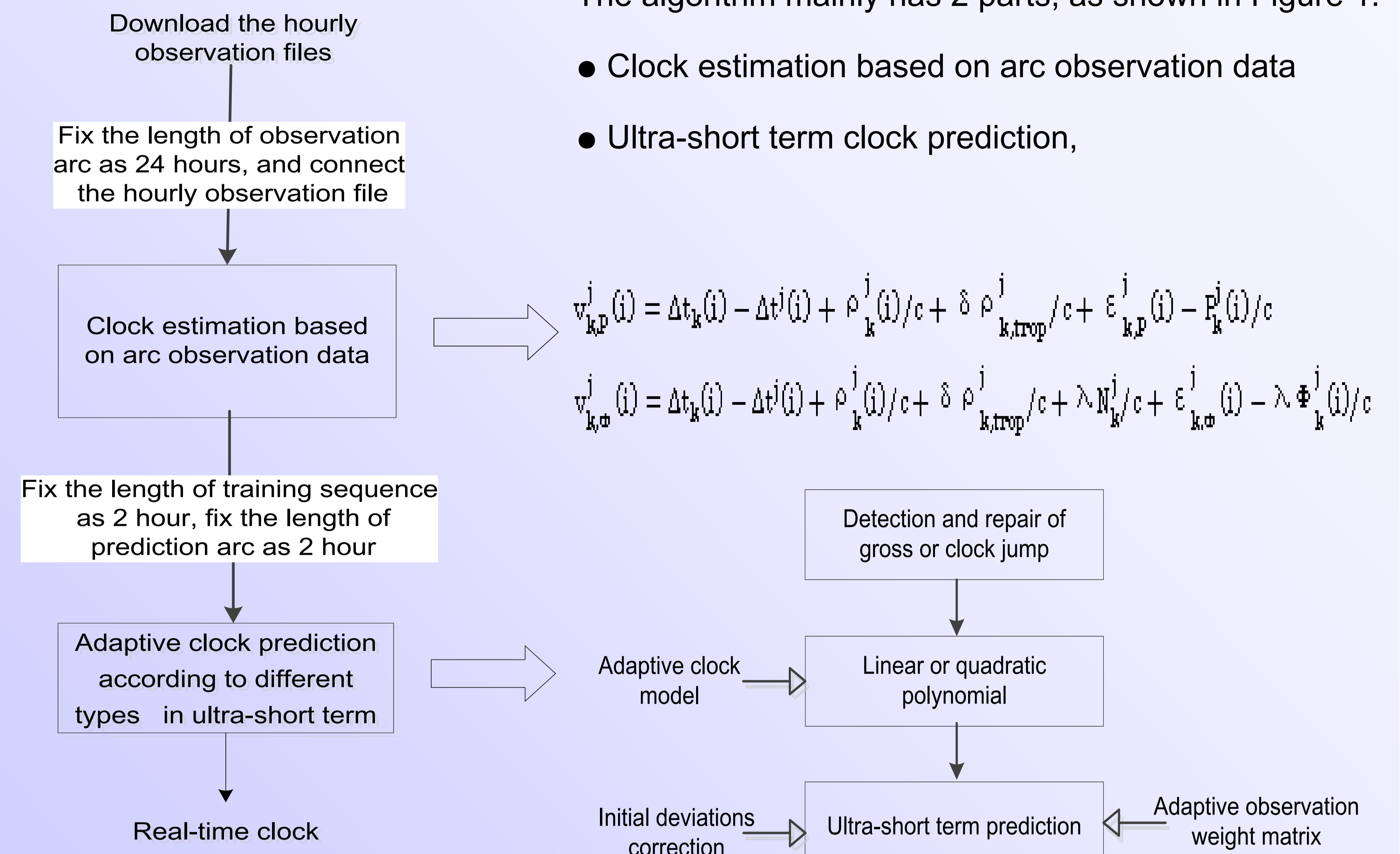


Fig. 1 Procedure of real-time satellite clocks generation based on connection of hourly observation files

The process is as follows:

- Download the hourly observation file;
- Fix the length of observation arc as 24 hours, then connect the hourly observation to form arc observation data;
- Estimate clock based on the arc observation data in slide window with step;
- Determine the length of training sequence is 2 hour and prediction arc as 2 hour;
- Adaptive clock prediction according to different types, then real-time clock is generated.

## Online validation

From DOY 116/2017, GPS real-time online validation is carried out. The validation is carried out based on hourly observation files, orbit is fixed as IGU-P, and the tracking station number is 100. The result are as shown in figure 2 and 3. From figure 3, it can be seen that because of the poor performance of Cs atomic clock carried on GPS 08 and GPS24, there is a big difference between GPS08, GPS24 with others.

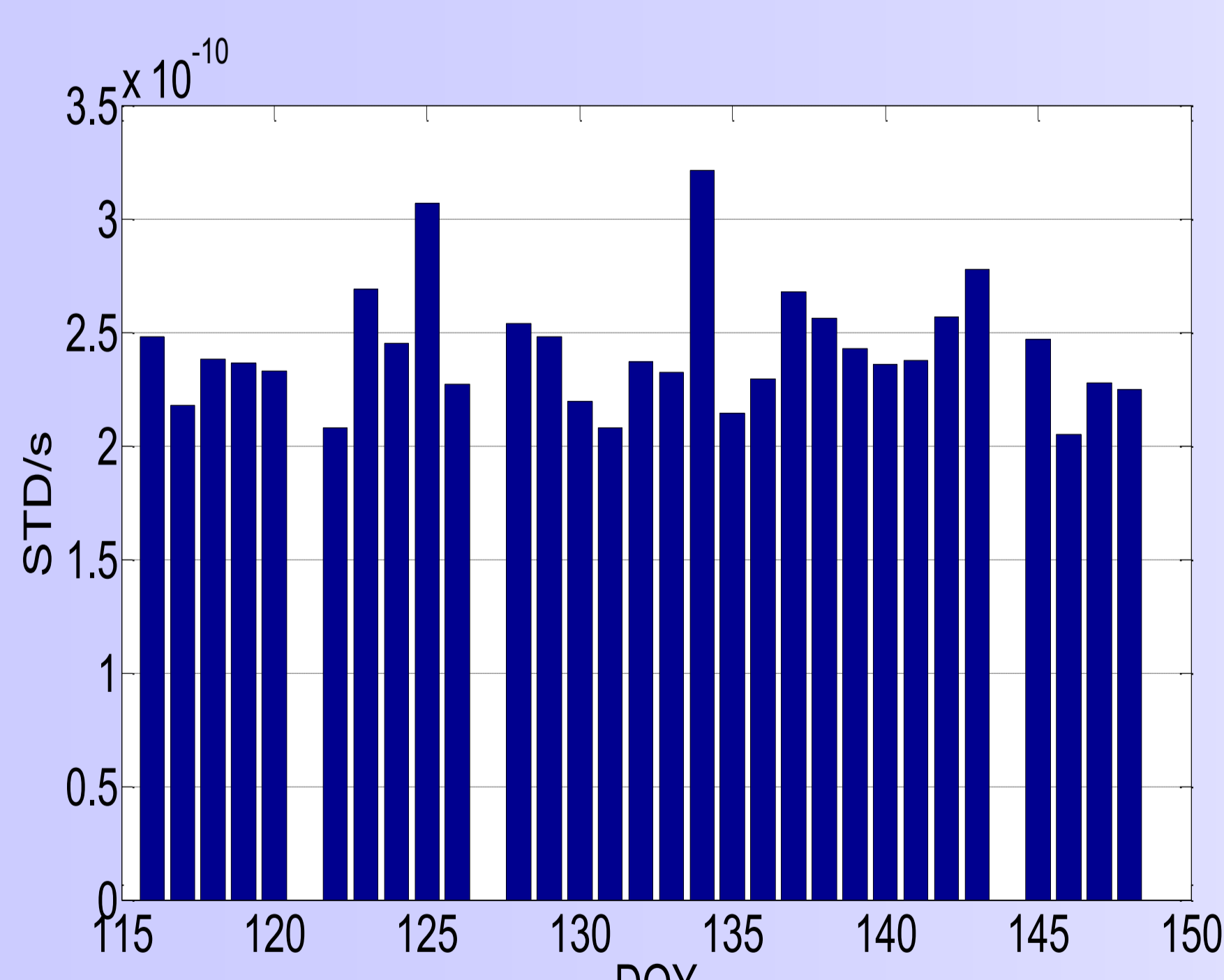


Fig.2 STD of GPS real-time clocks in validation.

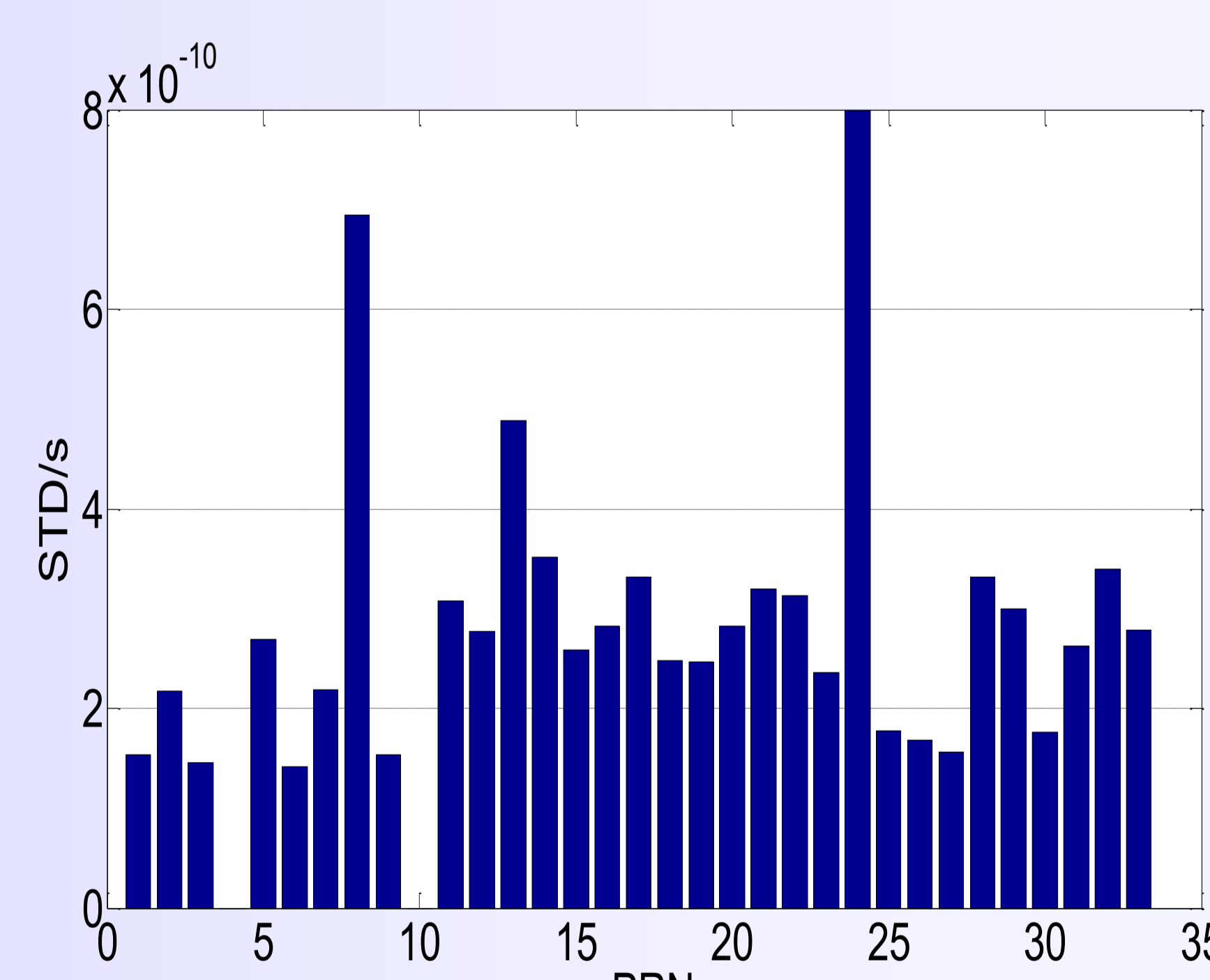


Fig.3 STD of real-time clocks of every GPS satellite

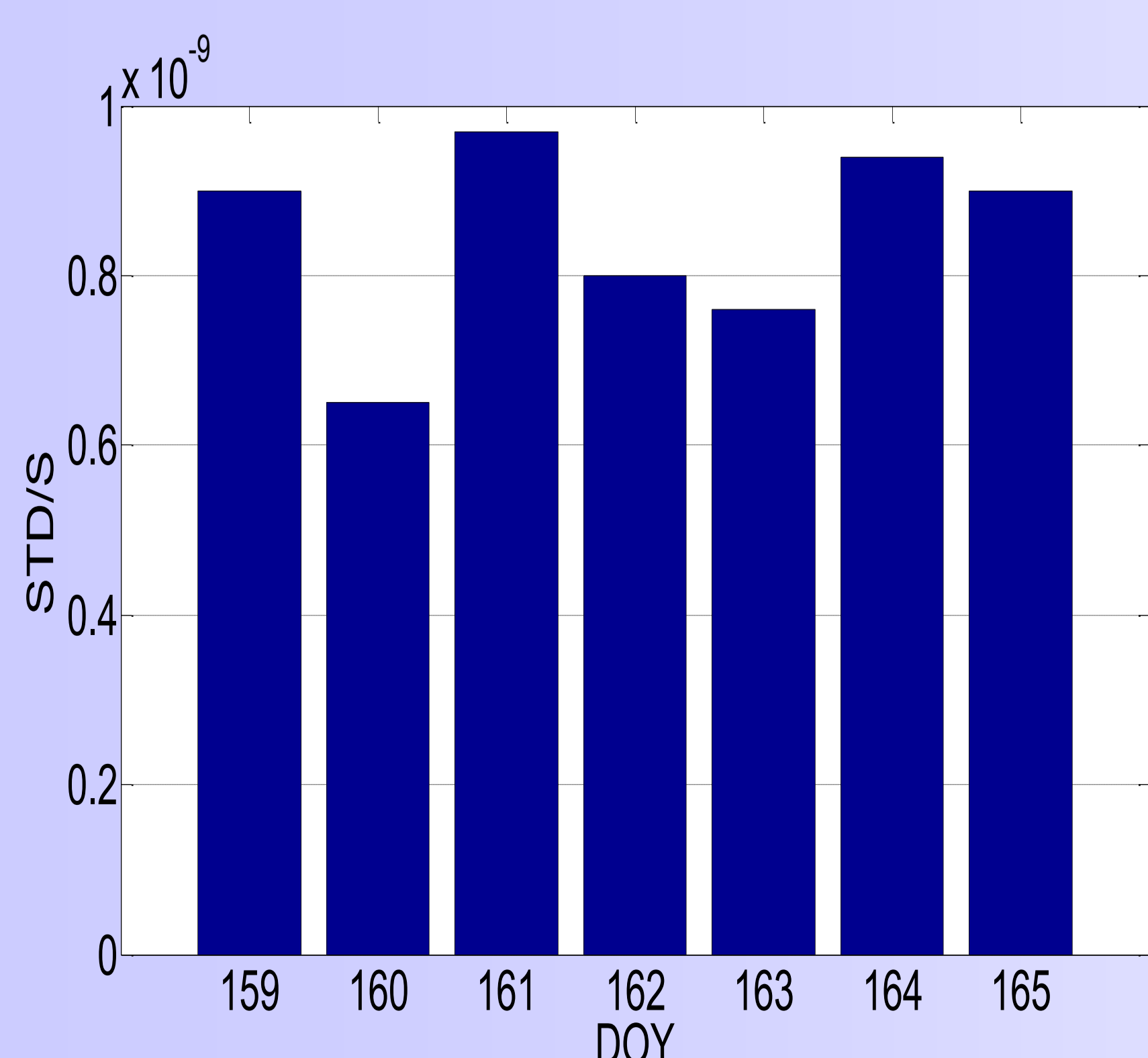


Fig.4 STD of BeiDou real-time clocks in validation.

From DOY 159/2017, BeiDou real-time online validation is carried out. The validation is carried out based on hourly observation files, orbit is fixed as GBU, and the tracking station number is about 30. Figure 4 shows a preliminary result of BeiDou real-time clocks. Compared with figure 2, it can be inferred that the precision of the orbit and a small number of stations maybe result in poor precision of BeiDou real-time clocks.

## Summary

- In order to supply an alternative choice for certain users who can not receive the real-time data stream because of the network condition, BeiDou/GPS real-time satellite clocks generation based on connection of hourly observation files is supposed in this contribution. Real-time clocks are generated by combining clocks estimation based on arc observation data with ultra-short term clocks prediction.
- The present validation result shows that the algorithm can supply a alternative choice for certain users. The STD of GPS real-time clocks generated by this algorithm is about 0.25ns, as the same level as IGS RTS.
- The preliminary result of BeiDou real-time clocks in validation is poor, which maybe the result of the poor precision of the orbit and a small number of stations. So the BeiDou real-time clocks should be improve later.

## Outlook

- To generate BeiDou real-time clocks using the novel algorithm based on more precise orbit and more tracking stations.
- To generate GLONASS/Galileo clocks based on the algorithm.
- To improve the clock prediction method for different navigation systems.