The study of the Residual of the Klobuchar Model in TaiWan

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Abstract

Ionospheric time delay is the mainly error source in Global Navigation Satellite Systems (GNSS). Ionospheric model is one of the ways to correct the ionospheric time delay. The single-frequency GNSS users modify the ionospheric time delay by receiving the correction parameters of the ionospheric model broadcasted by the satellites. Klobuchar model is widely used in Global Positioning System (GPS) and COMPASS because it is simple and convenient for real-time calculation. Klobuchar model is established on the observation mainly from Europe and USA. Its validation in China has not been fully studied. South of China is near the north crest of the equatorial anomaly, where the ionosphere has complicated temporal and spatial variation. The research on the validation in this region becomes very urgent and important.

In this paper, eleven years data from one GPS receiver located at Taoyuan Taiwan (121 ℃E, 25 ℃N) is used to study the long-term variation and distribution of the residual of Klobuchar model in Taiwan. TEC from the dual-frequency GPS observation is calculated and used as the reference, and the TEC based on the Klobuchar model is compared with the reference. The residual of the model is defined as the difference between the TEC from Klobuchar model and the reference. The results showed that the variation of the residual is similar to that of TEC. The residual in the daytime is larger than that at night. The monthly means of the residual vary with the solar activities and seasons. They are larger in the high solar activity years and small in the low activity years. The maximum appears in the equinox's months; and the minimum is in the solstice's months. In April 2014, the model underestimated the TEC 35TECU on average during 1300~1500BJT.

The probability distribution of the residual are also studied during the 1300~1500BJT and 0000~0200BJT respectively. The probability density does not obey Gaussian distribution in most occasions in this paper. The distribution is the most concentrated in June. During 1300~1500BJT in June 2008, the maximum of probability is 18%; and the maximum is 10% in June 2013. While in December 2008, the maximum is only 4%. The probability is not symmetrical on the maximum.

The spatial distribution of the residual is studied by calculating the probability density in each 2 degree from 16 ℃N to 32 ℃N. The results showed that the distribution is the most scattered in 20~24 ℃N latitudes and the most concentrated in 30~32 ℃N latitudes. Most of the residual is negative in 20~24 ℃N latitudes, manifesting the

estimation from the model is lower than the observations. In low solar activity years, most of the residual during 1300~1500BJT is larger than zero in 30~32 ℃N latitudes, while in high solar activity years the number of the positive residual is approximate to the negative ones.

Key words: ionospheric model, residual of Klobuchar model, TEC, distribution of the residual, solar activity