

Impact of GIMs with High Temporal Resolution in GNSS Positioning for Low and High Solar Activity Periods

Abstract

The ionosphere is an important part of the earth's atmosphere, which is partially or completely ionized by high-energy solar radiation. It is generally believed that the height of the ionosphere extends from 60 km to 1000 km. There are many free electrons and ions in the ionosphere, which can change the velocity and direction of radio waves, and refract, reflect and scatter them. Ionosphere will have a great impact on satellite navigation signals, usually leading to a delay of 5-10 meters, which can reach more than 10 meters in high solar activity years.

In this paper, the main characteristics of the ionosphere and various anomalies caused by solar activity are described. In this paper, the global probability distribution of ionospheric biting-out in different solar activity periods and seasons is analyzed by using high temporal resolution global ionospheric products. The results show that:

- 1) The spatial distribution of midday bite-out is closely related to geomagnetic latitude;
- 2) When the solar activity is low, the probability of occurrence in the mid latitude and polar regions of the northern hemisphere is higher in spring and summer; In autumn and winter, the probability of occurrence in the middle and high latitudes and the Arctic region of the southern hemisphere is high, while the probability of occurrence in the low latitudes is low;
- 3) When the solar activity is high, the probability of transmission is high in the middle and high latitudes and polar regions of the northern hemisphere in summer; In autumn and winter, the probability of occurrence in the middle and high latitudes of the southern hemisphere is higher than that in the polar regions of the northern hemisphere, and there is almost no noon-time bite-outs in the middle and low latitudes.

At the same time, this paper also studies the influence of global ionospheric products with different temporal resolution on satellite positioning. By collecting the observation data of several GNSS stations in different parts of the world, this paper analyzes the influence of ionospheric products on satellite positioning (positioning accuracy and convergence) under different solar activities, seasons and temporal resolutions.

- 1) When the solar activity is low, the influence of various ionospheric products on GNSS positioning is low;
- 2) Affected by the ionosphere, the positioning accuracy of GNSS in summer is significantly higher than that in spring and winter;
- 3) When the solar activity is high, the convergence of BCOM and B5MG high-resolution products is helpful to improve the positioning accuracy of GNSS.

To sum up, this paper studies the temporal and spatial distribution characteristics of ionospheric biting-out in the noon-time and the application of high-resolution global ionospheric products in GNSS positioning. The relevant results are helpful to further improve and update the global ionospheric model in the future, and also play an important role in GNSS positioning performance evaluation.

Key words: ionosphere, noon-time bite-out, high temporal resolution, global ionospheric products, navigation and positioning