PERFORMANCE EVALUATION OF USTEC PRODUCT FOR SINGLE-FREQUENCY PRECISE POINT POSITIONING

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Geodetic-grade dual-frequency GPS receivers are typically used for precise point positioning (PPP). Unfortunately, these receiver systems are expensive and may not provide a cost-effective solution in many instances. The use of low-cost single-frequency GPS receivers, on the other hand, are limited by the effect of ionospheric delay. A number of mitigation techniques have been proposed to account for the effect of ionospheric delay for single-frequency GPS users. Unfortunately, however, those mitigation techniques are not suitable for PPP. More recently, the U.S. Total Electron Content (USTEC) product has been developed by the National Oceanic and Atmospheric Administration (NOAA), which describes the ionospheric total electron content in high resolution over most of North America. This paper investigates the performance of USTEC and studies its effect on single-frequency PPP solution. A performance comparison with two widely-used ionospheric mitigation models is also presented.

Les récepteurs GPS à double fréquence de classe géodésique sont habituellement utilisés pour le positionnement ponctuel précis (PPP). Malheureusement, ces systèmes de récepteurs sont dispendieux et n'offrent pas nécessairement une solution rentable dans de nombreux cas. D'autre part, l'utilisation de récepteurs GPS à fréquence unique de faible coût est limitée par l'effet du retard ionosphérique. Un grand nombre de techniques d'atténuation ont été proposées pour tenir compte de l'effet du retard ionosphérique pour les utilisateurs du GPS à fréquence unique. Malheureusement, ces techniques d'atténuation ne conviennent toutefois pas au PPP. Récemment, le produit américain de contenu total des électrons (USTEC) a été développé par la National Oceanic and Atmospheric Administration (NOAA), lequel décrit le contenu total des électrons ionosphériques en haute résolution au-dessus de la plus grande partie de l'Amérique du Nord. Le présent article examine la performance du produit USTEC et étudie son effet sur la solution PPP à fréquence unique. Une comparaison de la performance avec deux modèles d'atténuation ionosphérique largement utilisés est également présentée.

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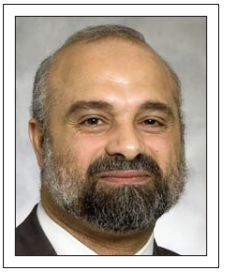

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1. Introduction

Precise point positioning (PPP) technique can achieve positioning accuracy at the centimetre level for static applications and at the decimetre level for kinematic applications, when dual frequency receivers are used [*Zumberge et al*. 1997]. However, many users employ low-cost single-frequency GPS receivers, which provide degraded carrier-phase based point positioning accuracy as a result of unmodeled ionospheric delay.

A number of mitigation techniques have been proposed to account for the effect of ionospheric delay for single-frequency GPS users. A widely-used empirical method to account for the effect of ionospheric delay is the Klobuchar model, whose coefficients are transmitted as part of the navigation message [*Klobuchar* 1991]. Although this model can be implemented in real time, it can only correct for 50-60% of the total ionospheric effect. *Yunck* [1996] proposed the group and phase ionospheric correction (GRAPHIC) method to eliminate the first-order ionospheric effect from single frequency data by combining the code and carrier-phase measurements. This method has the advantage of a complete removal of the first-order ionospheric error. However, the ambiguity parameters of the phase measurements need to be estimated. As a result, a relatively long time is required for the float ambiguities to converge. In addition, the noise level of this combination is affected by the high noise of code measurements.

The global ionospheric maps (GIM) product provided by the International GNSS Service (IGS) offers an alternative way to mitigate the ionospheric delay. The two-dimensional GIM file contains the vertical total electron content (TEC) grid values and the differential code biases (DCBs) of the satellites and stations in the IONosphere map EXchange