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The effects of satellite azimuths on mapping function in single layer ionospheric model

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For single layer ionospheric model, the conversion of slant total electron content (TEC) to vertical TEC at the ionospheric pierce point (IPP) is mainly based on a simple mapping function with the assumption of no horizontal gradients in the ionosphere. However, the mapping function usually depends on the single layer height and satellite elevation, without considering the satellite azimuth. To investigate the effects of different satellite azimuths, a comprehensive assessment was conducted with the statistical analysis derived from GPS observables and numerical simulations based on NeQuick2 model. Firstly, the comparisons of TEC at coinciding pierce points were performed by using GPS observables recorded by globally distributed stations of International GNSS Service (IGS). It is shown that the error caused by ionospheric spatial gradient could be up to tens of TECu in low latitudes. Because the observables could not be used to obtain TEC at arbitrary satellite azimuth for a given IPP, it was necessary to make a series of numerical simulations based on NeQuick2 ionospheric model. Given the single layer height and satellite elevation, the errors of ionospheric mapping functions caused by different satellite azimuths were analyzed systematically. It was found that the mapping errors were roughly symmetrical with respect to the geomagnetic equator on a global scale, and also symmetrical about the azimuth of 0° or 180° for a given location. In addition, the mapping errors were closely related to the distribution of ionospheric gradients, which means mapping errors were larger at the azimuth of larger TEC gradient and smaller at the azimuth of smaller TEC gradient. Therefore, the TEC conversion errors introduced by satellite azimuths should be considered when a simple mapping function is used in ionospheric single layer model.