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Global Application of TaiWan Ionospheric Model to Single-Frequency GPS Positioning

E. Macalalad (1), L.C. Tsai (1,2), and J. Wu (2)

(1) Institute of Space Science, National Central University, Jhongli City, Taiwan (ROC)., (2) Center for Space and Remote Sensing Research, National Central University, Jhongli City, Taiwan (ROC).

Ionospheric delay is one the major sources of error in GPS positioning and navigation. This error in both pseudorange and phase ranges vary depending on the location of observation, local time, season, solar cycle and geomagnetic activity. For single-frequency receivers, this delay is usually removed using ionospheric models. Two of them are the Klobuchar, or broadcast, model and the global ionosphere map (GIM) provided by the International GNSS Service (IGS). In this paper, a three dimensional ionospheric electron (ne) density model derived from FormoSat3/COSMIC GPS Radio Occultation measurements, called the TaiWan Ionosphere Model, is used. It was used to calculate the slant total electron content (STEC) between receiver and GPS satellites to correct the pseudorange single-frequency observations. The corrected pseudorange for every epoch was used to determine a more accurate position of the receiver. Observations were made in July 2, 2011(Kp index = 0-2) in five randomly selected sites across the globe, four of which are IGS stations (station ID: cnmr, coso, irkj and morp) while the other is a low-cost single-frequency receiver located in Chungli City, Taiwan (ID: isls). It was illustrated that TEC maps generated using TWIM exhibited a detailed structure of the ionosphere, whereas Klobuchar and GIM only provided the basic diurnal and geographic features of the ionosphere. Also, it was shown that for single-frequency static point positioning TWIM provides more accurate and more precise positioning than the Klobuchar and GIM models for all stations. The average %error of the corrections made by Klobuchar, GIM and TWIM in DRMS are 3.88%, 0.78% and 17.45%, respectively. While the average %error in VRMS for Klobuchar, GIM and TWIM are 53.55%, 62.09%, 66.02%, respectively. This shows the capability of TWIM to provide a good global 3-dimensional ionospheric model.