On High-Resolution TEC Derivation from Regional GPS Networks: Feasibility Study

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GPS technique proved to be a powerful tool for studying Earth's ionosphere. Currently, many GPS analysis centers provide global ionosphere maps (GIM) on a daily basis. However, the resolution of these products is not sufficient to study local ionospheric structures. GIMs available on the Internet show routinely 15-minute temporal resolution at best, based on standard International GPS Service (IGS) data with 30-second sampling rate. Spatial resolution is around several degrees in latitude and longitude. Thus, GIMs cannot be used in detecting short-lasting processes with duration of about 1–10 min, much less in detecting virtually simultaneous disturbances on a global scale. Dual-frequency GPS carrier phase observables can be measured with high accuracy, allowing TEC estimation with a relatively small error less than 1 TECU (TEC unit) with possible uncertainty in the initial value. Even though an initial uncertainty may exist, the epoch-by-epoch TEC change can be determined with a high accuracy.

In this study, a zero-difference approach will be used for TEC determination from double frequency GPS data collected by a dense GPS CORS network (70 to 40 km station separation, 1Hz sampling rate). In order to demonstrate the capability of these data to detect local ionospheric features, we compare 1-second TEC data from Ohio CORS to the results obtained with standard IGS 30-second sampling rate. Sample periods of geomagnetic quiet and disturbed conditions are selected for demonstration purposes. For an undisturbed ionosphere, dual frequency GPS receiver observations show a flat TEC signature. When disturbances appear in the ionosphere, the calculated TEC will fluctuate reflecting the quick variations in the received carrier-to-noise ratio.

The contribution of this paper is a technology demonstration, which we believe, will enable detection of medium to small scale ionospheric irregularities, especially medium to small scale traveling ionospheric disturbances (TIDs), supporting nowcasting and forecasting of space weather, vital to radio-navigation, communication and surveillance.