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Near real time modeling of the local ionospheric VTEC with particle filter using ground base GPS observations

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Ionosphere modeling is an important field of current studies because of its influences on the propagation of the electromagnetic signals. Among the various methods of obtaining ionospheric information, Global Positioning System (GPS) is the most prominent one because of extensive stations which are distributed all over the world. There are several studies in the literature related to the modeling of the ionosphere in terms of Total Electron Content (TEC). However, most of these studies investigate the ionosphere in the global and regional scales. On the other hand, complex dynamic of the ionosphere requires further studies in the local structure of the TEC distribution. In this work, Particle filter has been used for the investigation of the local character of the ionospheric Vertical Total Electron Content (VTEC). The GPS data of 29 ground based GPS stations, belonging to International GNSS Service (IGS) and Reference Frame Sub-commission for Europe (EUREF), for Europe have been used in this study. The data acquisition time is 18 February 2011 and the data is affected by the 15 February geomagnetic storm. In the preprocessing step, the observations of each satellite are examined for any possible cycle slip and also geometry-free linear combination of the observables are calculated for each continuous arc. Then, Pseudorange observations smoothed with the carrier to code leveling method.
Particle filter is used for near-real time estimation of the VTEC and of the combined satellite and receiver biases. The Particle filter is implemented by recursively generating a set of weighted samples of the state variables. This filter has a flexible nature which can be more adaptive to some characteristics of the high dynamic systems. Besides, standard Kalman filter as an effective method for optimal state estimation is applied to the same data sets to compare the corresponding results with results of Particle filter. The comparison shows that Particle filter indicates better performance than the standard Kalman filter especially during the geomagnetic storm.

Keywords: ionosphere, GPS, Kalman filter, Particle filer