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Assessment of ionospheric threat modeling techniques over Marmara Region

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It is generally known that extreme ionospheric density associated with severe magnetic storm degrades the Global Navigation satellite Systems (GNSS) measurements also at mid - to high latitudes. Strong solar activity can cause large local spatial and temporal gradients in the delays induced on the GNSS signals by the ionosphere. The local nature of gradients can result in significant decorrelation between Ground Based Augmentation System (GBAS) Ground Stations and the GNSS receiver on board the aircraft. For the mitigation of this effect either a special functional architecture is established to monitor the ionosphere on the basis of so called Extended GBAS or ionospheric threat models can be constructed for a certain region.

In this work two different techniques have been evaluated for the estimation of ionospheric threat model parameters consisting of width, slope and velocity of the ionospheric wave front by using real ground-based observations from both GPS and GLONASS in the Marmara Region. The data collected between 2012 and 2015 also containing high ionospheric activities are pre-processed to extract ionospheric gradients. Ionospheric delays at each ionospheric piercing point are determined by applying a local ionospheric Total Electron Content (TEC) modeling and filtering techniques on the basis of raw carrier-phase observations. The ionospheric fronts are searched by looking at high ionospheric gradients which result from ionospheric delay differences between ionospheric piercing points.

The first technique of the threat model evaluation is based on the propagation of an ideal plane wave as a wave front, velocity of which is estimated on the basis of a Gauss Markov Model using an ordinary least square estimation procedure. The remaining parameters namely slope and width are calculated afterwards using rate of change gradients and the duration of the wave front in context with the estimated front velocity. In the second technique both the magnitude of the velocity (speed) and the orientation of the front are estimated together again using a Gauss Markov Model where the direction of propagation is calculated in a second stage. Finally, the estimated threat model parameters are examined and assessed by comparing the results from these two techniques.