



Forming an optimal GNSS Network for 2-D Ionospheric mapping by Unsupervised Machine Learning Algorithm for any geographical boundary

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Abstract

GNSS-networks that provide necessary spatial and temporal resolution are highly needful to understand the ionospheric responses at different spatial and temporal scale lengths. Formation of a ground GNSS network employing either or all of GPS, GNSS and NavIC signal receiving stations depends on various factors such as scientific objectives, topography and, financial and human resources.

A new algorithm is developed using an unsupervised machine learning approach that aids in the optimal placement of receivers over a given region of interest. Through the precise orbital information of multi-GNSS satellite measurements, required spatial grid spacing and temporal resolution as the dominant features, a clustering mechanism using K-means methodology is rigorously utilized for optimal and adaptive placement of GNSS receivers. As a case study, a regional network over the Indian landmass is simulated. The idea is to understand how better the receivers can be placed over the Indian region under 0.5×0.5 (~ 50 km X 50 km) of grid spacing with 1 hour resolution of 2-D VTEC image. The reliable metrics like, the normalized empty grid ratio, sigma bound value and probability density values are prescribed to decipher the optimal numbers in different configurations for a particular region. The ionospheric VTEC maps are generated using NeQuick-G model over the finalized GNSS network and resolution of ionospheric features and gradients in the product maps are examined using real observations at selected grid points. The algorithm can now be readily adopted for any region of the globe for optimally placing GNSS receivers for a pre-defined spatio-temporal resolution of the product 2-D VTEC map.

Keywords: Machine Learning, Unsupervised Classification, 2-D TEC map, GNSS, GPS, NavIC