Geophysical Research Abstracts,
Vol. 11, EGU2009-6962, 2009
EGU General Assembly 2009

Space Weather Activities of IONOLAB Group: TEC Mapping

F. ARIKAN (1), A. YILMAZ (2), O. ARIKAN (3), I. SAYIN (4), M. GURUN (5), K.E. AKDOGAN (6), and S.A. YILDIRIM (7)

(1) Hacettepe University, Ankara, Turkey (arikan@hacettepe.edu.tr, 90 312 299 2125), (2) Hacettepe University, Ankara, Turkey (ayilmaz@hacettepe.edu.tr, 90 312 2992125), (3) Bilkent University, Ankara, Turkey (oarikan@ee.bilkent.edu.tr, 90 312 2664192), (4) Hacettepe University, Ankara, Turkey (isiltan@ee.hacettepe.edu.tr, 90 312 2992125), (5) TUBITAK UZAY, Ankara Turkey (melike.gurun@uzay.tubitak.gov.tr), (6) Hacettepe University, Ankara, Turkey (kurtulus@ee.hacettepe.edu.tr, 90 312 2992125), (7) Hacettepe University, Ankara, Turkey

Being a key player in Space Weather, ionospheric variability affects the performance of both communication and navigation systems. To improve the performance of these systems, ionosphere has to be monitored. Total Electron Content (TEC), line integral of the electron density along a ray path, is an important parameter to investigate the ionospheric variability. A cost-effective way of obtaining TEC is by using dual-frequency GPS receivers. Since these measurements are sparse in space, accurate and robust interpolation techniques are needed to interpolate (or map) the TEC distribution for a given region in space. However, the TEC data derived from GPS measurements contain measurement noise, model and computational errors. Thus, it is necessary to analyze the interpolation performance of the techniques on synthetic data sets that can represent various ionospheric states. By this way, interpolation performance of the techniques can be compared over many parameters that can be controlled to represent the desired ionospheric states. In this study, Multiquadrics, Inverse Distance Weighting (IDW), Cubic Splines, Ordinary and Universal Kriging, Random Field Priors (RFP), Multi-Layer Perceptron Neural Network (MLP-NN), and Radial Basis Function Neural Network (RBF-NN) are employed as the spatial interpolation algorithms. These mapping techniques are initially tried on synthetic TEC surfaces for parameter and coefficient optimization and determination of error bounds. Interpolation performance of these methods are compared on synthetic TEC surfaces over the parameters of sampling pattern, number of samples, the variability of the surface and the trend type in the TEC surfaces. By examining the performance of the interpolation methods, it is observed that both Kriging, RFP and NN have important advantages and possible disadvantages depending on the given constraints. It is also observed that the determining parameter in the error performance is the trend in the Ionosphere. Optimization of the algorithms in terms of their performance parameters (like the choice of the semivariogram function for Kriging algorithms and the hidden layer and neuron numbers for MLP-NN) mostly depend on the behavior of the ionosphere at that given time instant for the desired region. The sampling pattern and number of samples are the other important parameters that may contribute to the higher errors in reconstruction. For example, for all of the above listed algorithms, hexagonal regular sampling of the ionosphere provides the lowest reconstruction error and the performance significantly degrades as the samples in the region become sparse and clustered. The optimized models and coefficients are applied to regional GPS-TEC mapping using the IONOLAB-TEC data (www.ionolab.org). Both Kriging combined with Kalman Filter and dynamic modeling of NN are also implemented as first trials of TEC and space weather predictions.