

Single station TEC modelling during storm conditions

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE of RHODES UNIVERSITY

By Jean Claude Uwamahoro

October 2015

ABSTRACT

It has been shown in ionospheric research that modelling total electron content (TEC) during storm conditions is a big challenge. In this study, mathematical equations were developed to estimate TEC over Sutherland (32.38oS, 20.81oE), during storm conditions, using the Empirical Orthogonal Function (EOF) analysis, combined with regression analysis. TEC was derived from GPS observations and a geomagnetic storm was defined for $Dst \leq -50$ nT. The inputs for the model were chosen based on the factors that influence TEC variation, such as diurnal, seasonal, solar and geomagnetic activity variation, and these were represented by hour of the day, day number of the year, F10.7 and A index respectively. The EOF model was developed using GPS TEC data from 1999 to 2013 and tested on different storms. For the model validation (interpolation), three storms were chosen in 2000 (solar maximum period) and three others in 2006 (solar minimum period), while for extrapolation six storms including three in 2014 and three in 2015 were chosen. Before building the model, TEC values for the selected 2000 and 2006 storms were removed from the dataset used to construct the model in order to make the model validation independent on data. A comparison of the observed and modelled TEC showed that the EOF model works well for storms with non-significant ionospheric TEC response and storms that occurred during periods of low solar activity. High correlation coefficients between the observed and modelled TEC were obtained showing that the model covers most of the information contained in the observed TEC. Furthermore, it has been shown that the EOF model developed for a specific station may be used to estimate TEC over other locations within a latitudinal and longitudinal coverage of 8.7o and 10.6o respectively. This is an important result as it reduces the data dimensionality problem for computational purposes. It may therefore not be necessary for regional storm-time TEC modelling to compute TEC data for all the closest GPS receiver stations since most of the needed information can be extracted from measurements at one location.