# FORECASTING OF IONOSPHERIC ELECTRON CONTENT (TEC) USING A TIME SERIES NEURAL NETWORK

## Introduction

Neural networks provide more effective techniques for TEC prediction in areas with uneven distribution of ground GNSS stations and low latitude regions where IRI model has shown poor performance. The low latitude features of the equatorial anomaly (equatorial electrojet (EJJ) & $ExB$ drift) contributes to complex dynamics of TEC. I propose a NARX technique with additional input of EJJ proxy and estimation of $ExB$ drift velocity that forecasts TEC during a high solar activity year.

## Research objectives

To improve the neural network performance in TEC prediction over the Northern equatorial anomaly crest region and compare it with IRI model

## Methodology

A data set of 2011-13 was used for model development and validation and 2014 for forecasting.

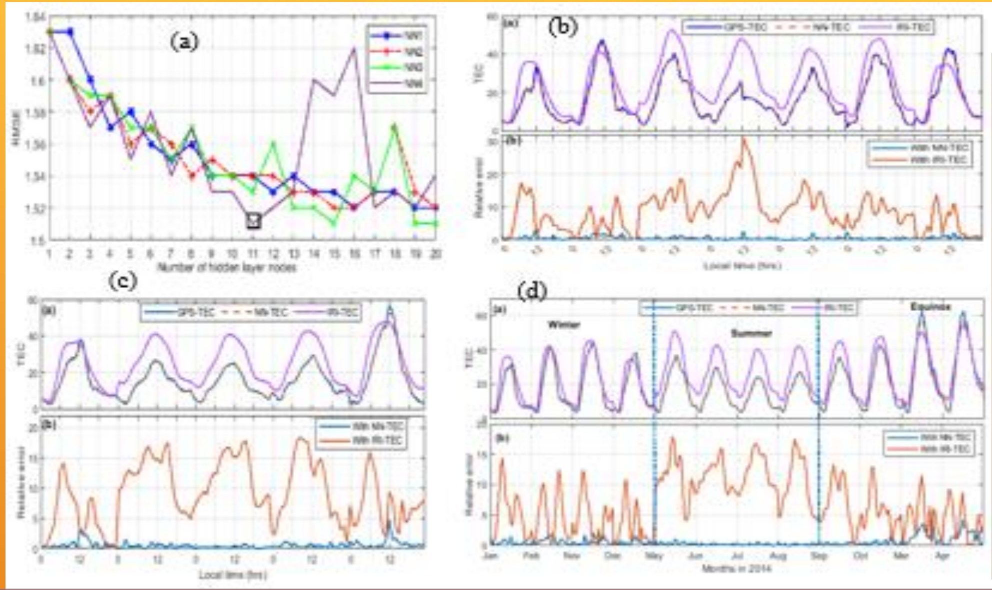
| # | Input parameters |
|---|---|
| NN1 | DSA, DCA, DSS, DCS, TC, TS, F10.7, NmF2, Dst, SWS |
| NN2 | DSA, DCA, DSS, DCS, TC, TS, F10.7, NmF2, Dst, SWS, $\Delta H$ |
| NN3 | DSA, DCA, DSS, DCS, TC, TS, F10.7, NmF2, Dst, SWS, $V_{ExB}$ |
| NN4 | DSA, DCA, DSS, DCS, TC, TS, F10.7, NmF2, Dst, SWS, $\Delta H, V_{ExB},$ |

Tab 1: A table showing the developed NNs with different input parameters

*V_ExB=-22.790 + 1.275DCA + 0.3275DSA - 1.9420DCS + 0.1111DSS - 11.680TC + 0.8074TC + 0.05703Dst + 0.04488F10.7 + 0.1934 dDst/dx* (Dubazane & Habarulema, 2018)

*ΔH= ΔHdip equator-ΔHoff dip equator* (Manoj, et al., 2006)

Performance assessment was done using RMSE and relative errors




## Results

Fig a: RMSE profile showing NN performance

Fig b: Forecast of quite days

Fig c: Forecast of storm days

Fig d: Forecast of monthly and seasonal variation

## Discussion and summary

The differences in diurnal variation for IRI depends on the selection of IRI parameters e.g., the 'ON' F-peak storm model and the CCIR or URSI option. The IRI results of seasonal variation confirms the seasonal anomalies showing December winter and semiannual anomaly which are controlled by changes in thermospheric winds and neutral composition. Generally, the NN technique performs better than IRI model. The possible sources of error in the IRI model include plasmasphere electron contribution the observed discrepancies in the correlation between seasonal values of F10.7 and EUV flux in 2013 and 2014 misrepresenting the solar activity in the IRI model, the missing representation of the equatorial electric fields and $ExB$ drift in the IRI model, failure of IRI model to predict the change in wind patterns and inadequate datasets to represent the low latitude ionospheric phenomena in the IRI model.

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