The performance evaluation of TEC variations over two equatorial stations and the three topside options in IRI-2012 Model

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Introduction/Motivation

Prediction models of total columnar electron content of the ionosphere (TEC) are of great value in the operations of radio communication systems.

A number of such models rely on measured data, but because of poor data coverage, some of these models do not perform well in some region of the earth, particularly in a large part of the African region.

Model validation helps in identifying areas of poor performance in order to help in the improvement of their predictive capabilities.

Objective

This study investigates the performance of the three topside option of the IRI-2012 model in predicting total electron content (TEC) over two equatorial stations; namely, Ilorin, Nigeria and Libreville, Gabon.

The topside ionospheric electron content model is calculated based on:

- ❑ NeQuick,
- ❑IRI-01 and
- ❑IRI-2001 corr

Data and Method

The slant total electron content (STEC) recorded by the GPS was used to calculate the vertical total electron content (VTEC) referred in this study as TEC, over two stations.

The TEC values were compared with the three topside options of the IRI-2012 model predictions .

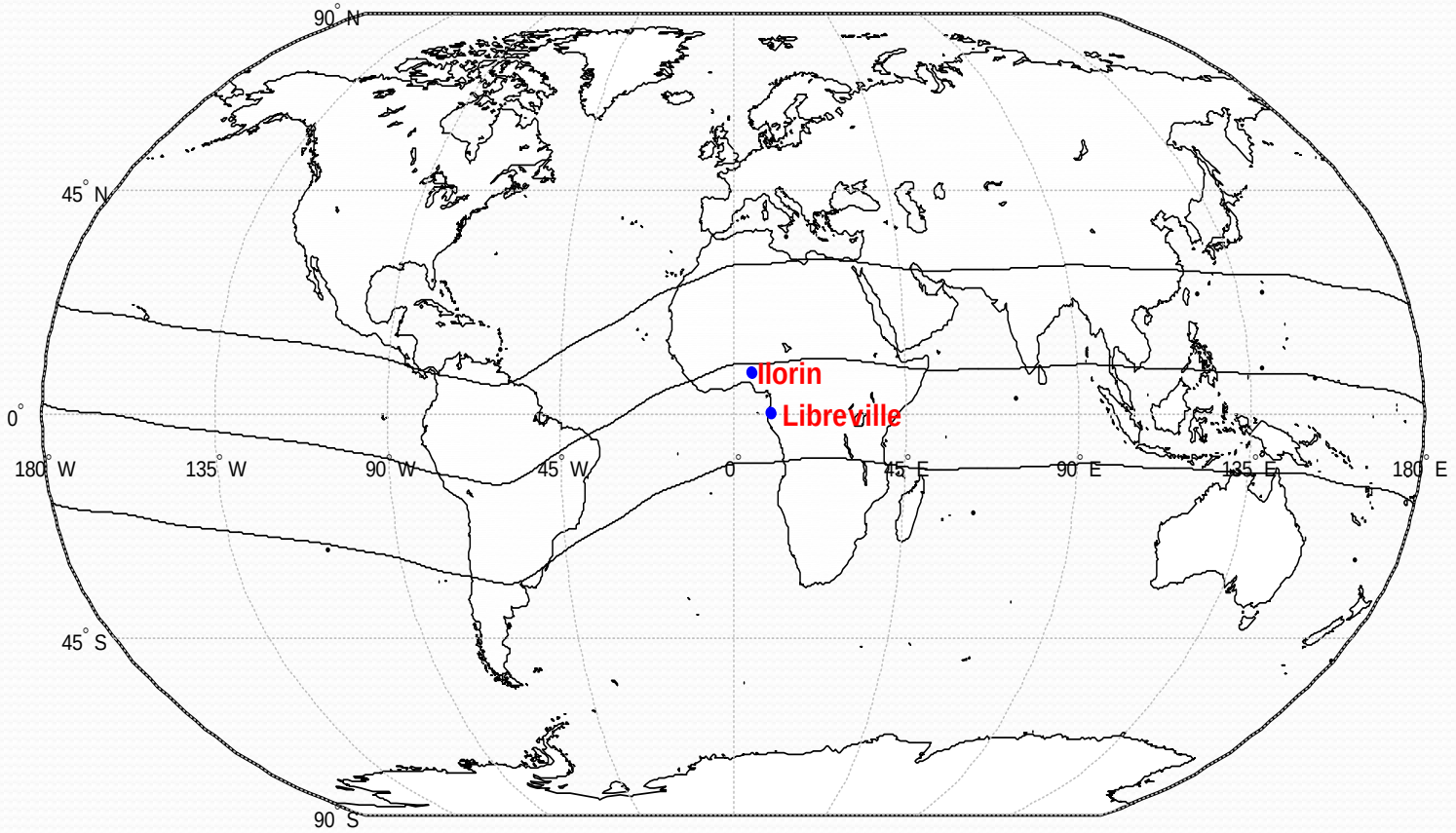
To achieve a better quantifiable estimate of the performance of the models, the Root Mean Square Error (RMSE) values were calculated for the three options, using equation (1):

$$\sqrt{\frac{1}{N}\sum_{I}^{N}(\beta_{measured}-\beta_{IRI})^2} \qquad (1)$$

The data-sets spans January-December, 2010, a year of low solar activity.

The ten magnetically quiet days data for each month were utilized.

Libreville
Geog. Coord: 0.03^0 N/9.68^0 E
Geomag. Coord: 8.05^0 S/81.05^0 E



Ilorin
Geog. Coord: 8.50^0 N/4.68^0 E
Geomag. Coord: 1.82^0 S/76.8^0 E

Fig. 1; World map showing location of the two stations

Fig.2(a); A Monthly Comparism of the measured TEC Values at Ilorin and Libreville

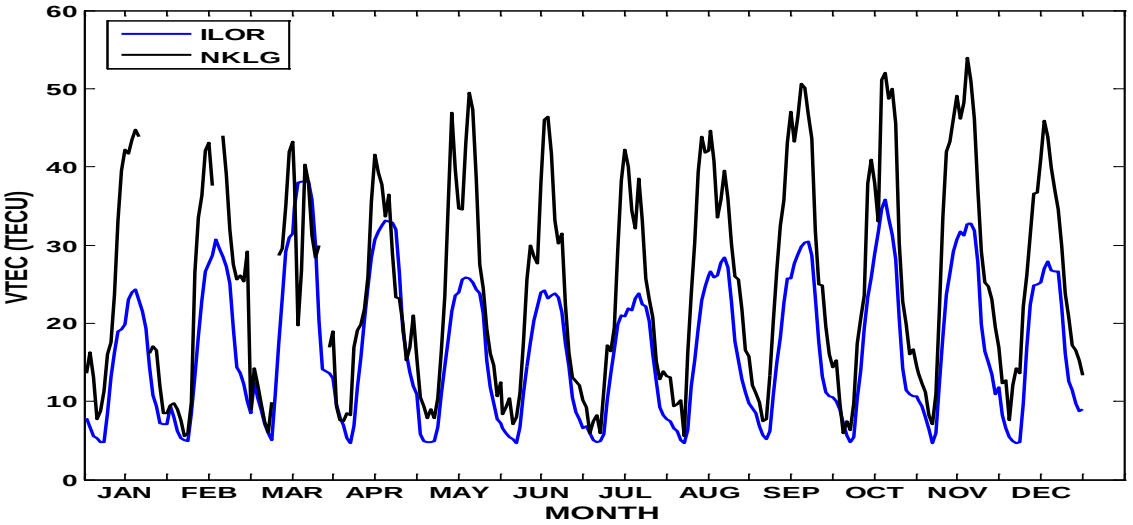
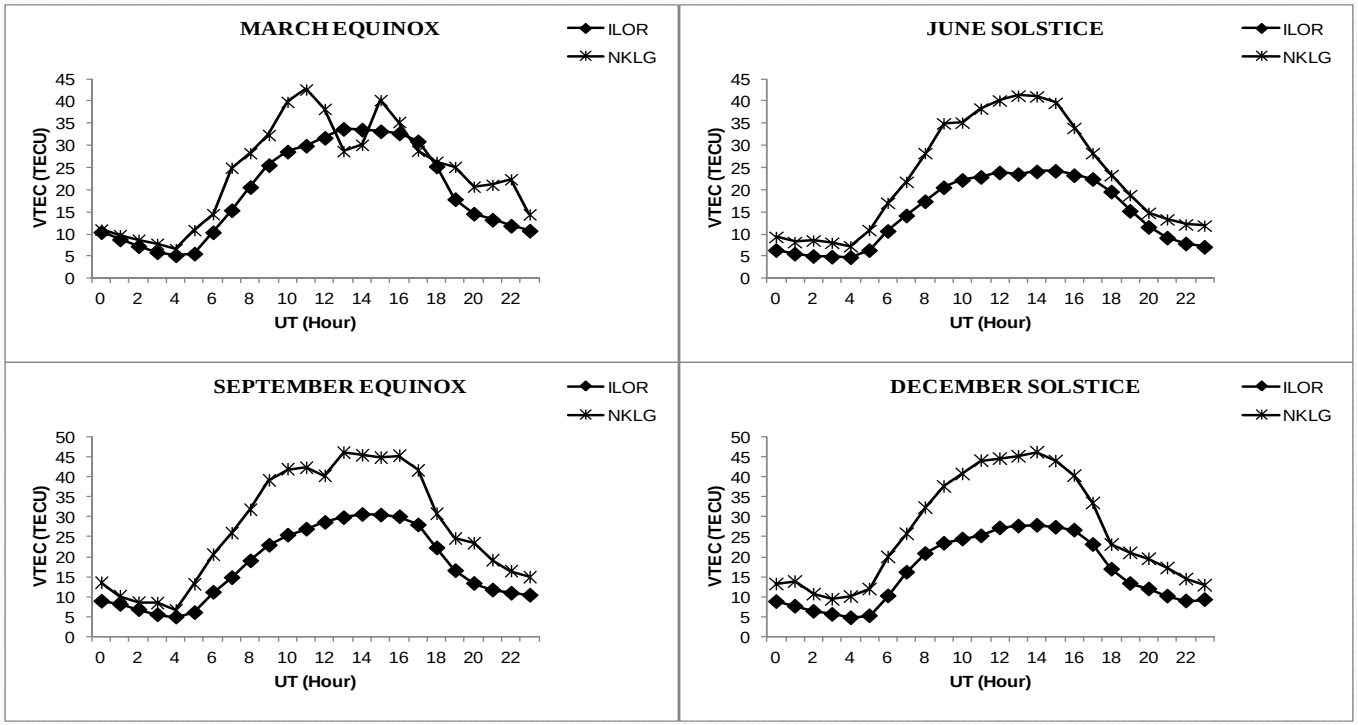


Fig.2(b); A Comparism of the measured TEC Values at Ilorin and Libreville at different seasons



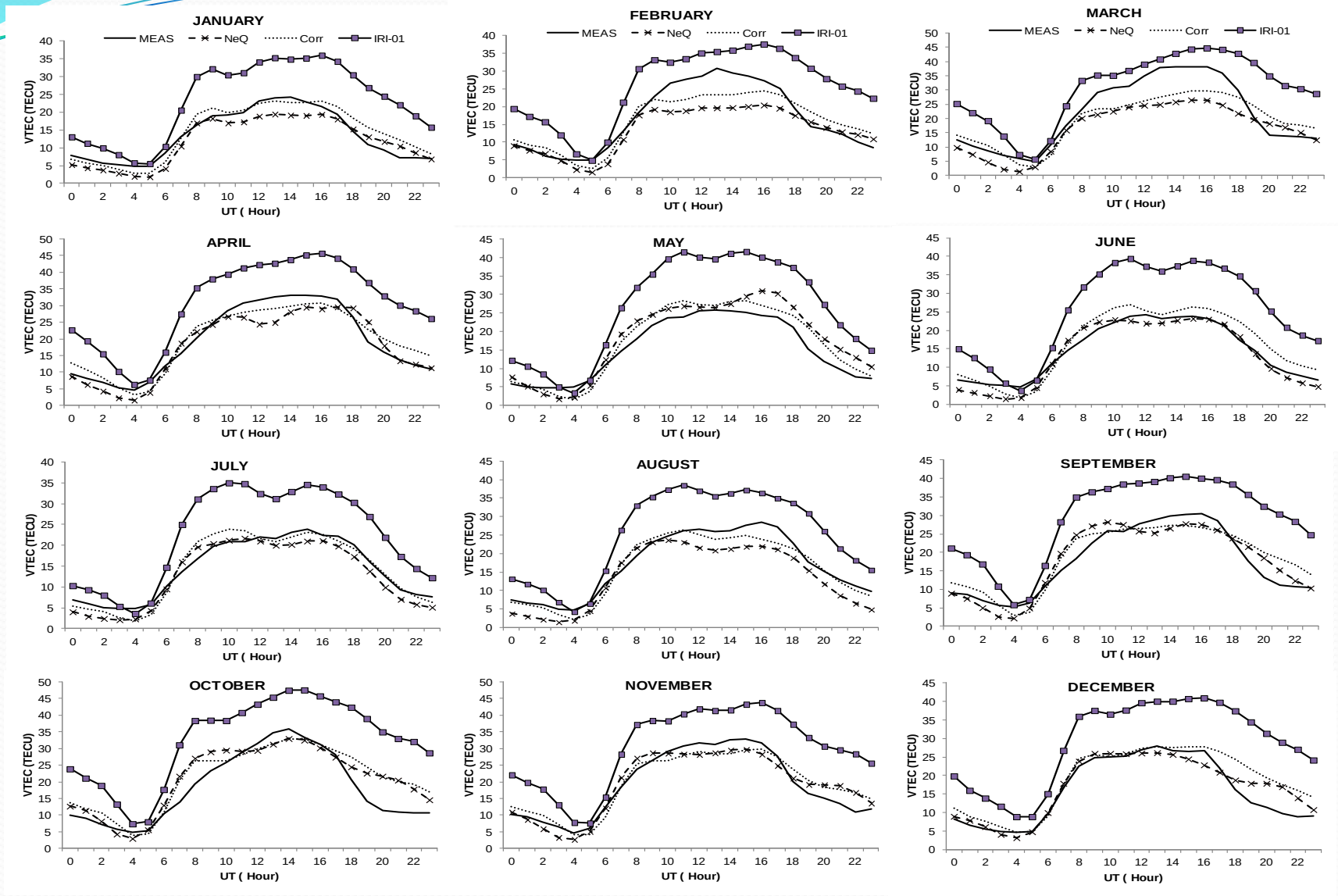


Fig. 3; Monthly Observation of the performance of the model at Ilorin

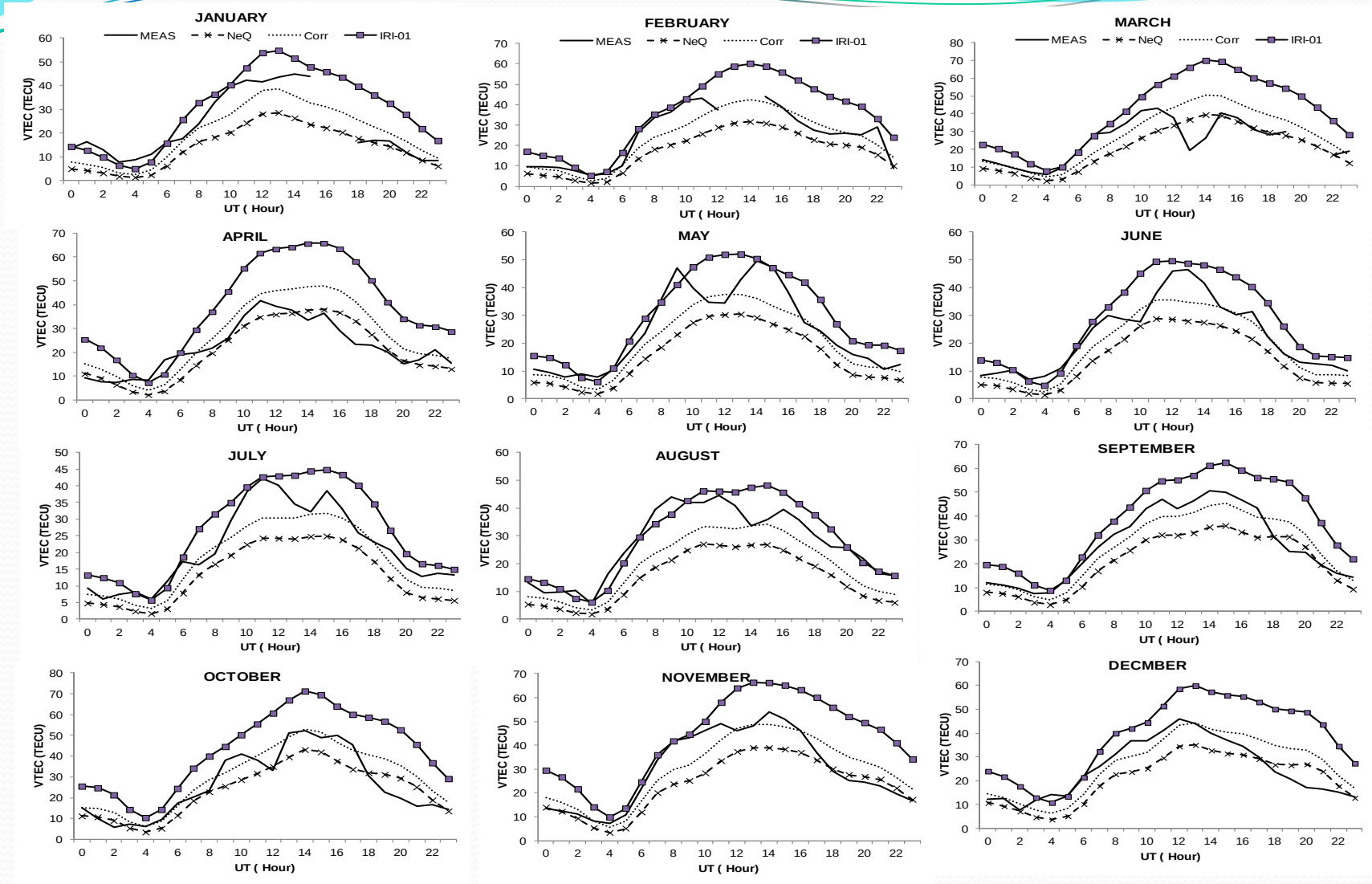


Fig. 4; Monthly Observation of the performance of the model at Libreville

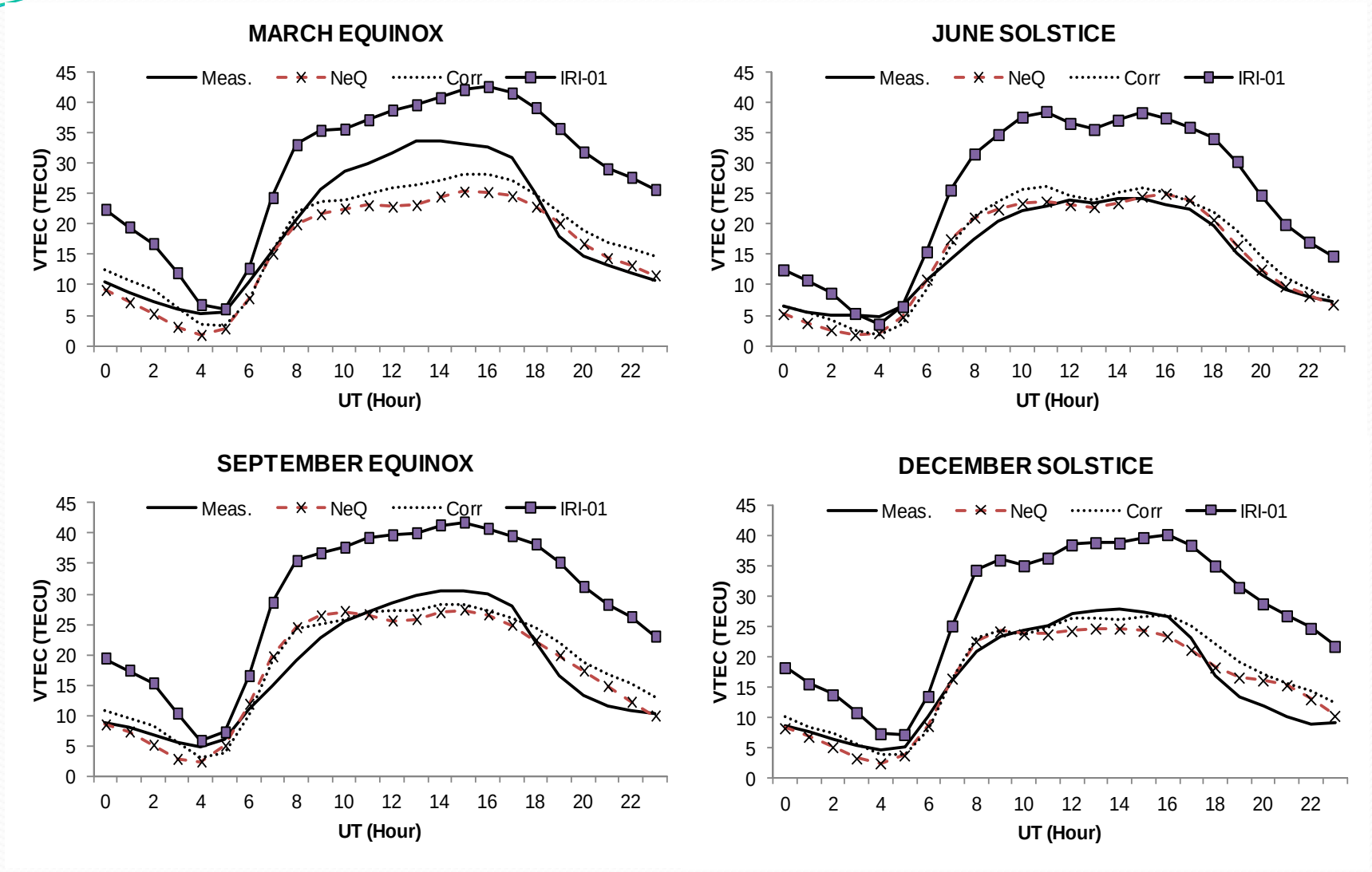


Fig. 5; Seasonal Observation of the performance of the model at Ilorin

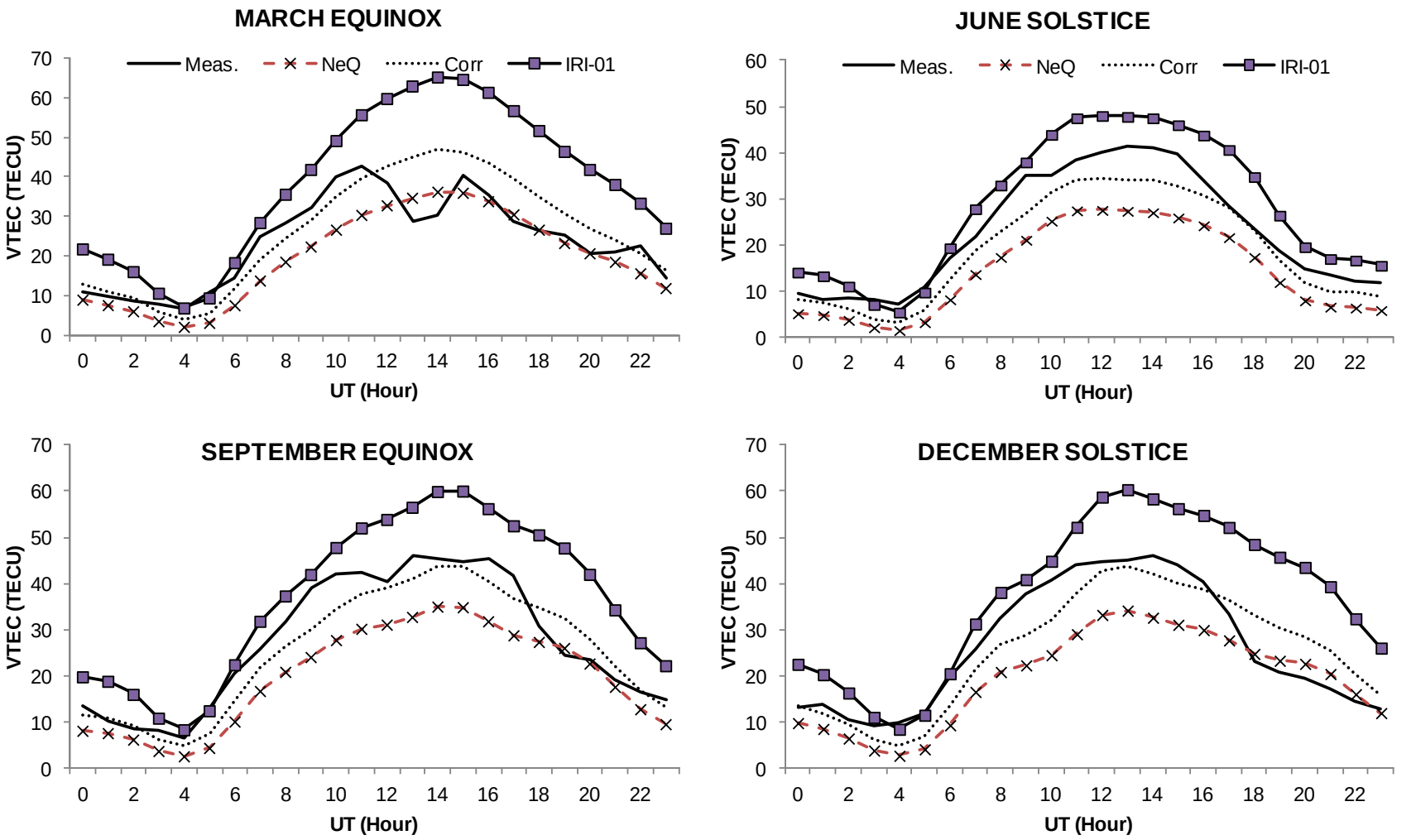


Fig. 6; Monthly Observation of the performance of the model at Libreville

Table 1. Seasonal RMSE values for the three topside options of IRI at Ilorin

MODEL OPTIONS	MAREQU	JUNSOL	SEPEQU	DECSOL
NeQuick	4.97	**1.73**	**2.87**	**2.50**
IRI 2001-Corr	**3.81**	2.26	3.01	2.83
IRI 2001	10.77	11.22	12.23	12.08

Table 2. Seasonal RMSE values for the three topside options of IRI at Libreville

MODEL OPTIONS	MAREQU	JUNSOL	SEPEQU	DECSOL
NeQuick	**6.46**	8.97	8.86	9.14
IRI 2001-Corr	6.74	**4.37**	**4.42**	**5.69**
IRI 2001	17.94	6.52	11.27	13.61

Conclusions

- TEC values measured at Libreville were observed to be higher than those measured at Ilorin during all months/seasons. The peak values of TEC ranges from 23-33 TECU at Ilorin, while at Libreville, it ranges from about 41-46 TECU

- The lowest TEC values were recorded during the June solstice and March equinox respectively at Ilorin and Libreville

- IRI-2001 shows significant discrepancies in TEC predictions, while the other two options (IRI-NeQuick and IRI-2001 corr.) give TEC values close to the experimental values at both stations, particularly during the night time.

- The discrepancies in the TEC predictions are generally higher at Libreville. This is partly attributed to the electrodynamics effect caused by electric and magnetic fields.

- There is a need for an improvement in the effect of the zonal electric field/ EXB drift captured in the IRI model for the low latitude with change in latitude.

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Thanks so much for your attention