

**COMMENT, RESPONSE AND EXPECTED CHANGES TO MANUSCRIPT  
BASED ON THE FIRST REFEREE REPORT (NUMBER 2) ON THE  
PAPER TITLED:**

**“THE TRANSIENT VARIATION OF THE COMPLEXES OF THE LOW  
LATITUDE IONOSPHERE WITHIN THE EQUATORIAL IONIZATION  
ANOMALY REGION OF NIGERIA”.**

**1. ANONYMOUS REFEREES COMMENTS**

The paper entitled ‘The Transient Variation of the Complexes of the Low Latitude Ionosphere within the Equatorial Ionization Anomaly Region of Nigeria’ by Rabiou et al. attempts to study the utility of Lyapunov exponents and Tsallis entropy computed from the total electron content (TEC) derived from GPS observations in characterization of the dynamical response of the dip equatorial ionosphere to external influences. One major shortcoming of the paper is the assumption on the part of the authors that the only external influence is due to magnetospheric forcing seen during magnetic storms. There is also significant forcing from below the ionosphere, which causes day-to-day variability, even during magnetically quiet periods, in the occurrence of the equatorial plasma bubble that produces the largest changes in the de-trended time series for daily TEC at a low latitude station, after the diurnal variation has been removed, as has been done in the present paper. It is not clear from the results presented in the paper, that non-linear dynamics of the low latitude ionosphere is mainly determined by geomagnetic storms and substorms. On the whole, the quality of the paper is poor, with some glaring errors mentioned in the next paragraph. The paper has several basic scientific issues that need to be addressed and corrected before the authors even proceed to present results pertaining to the non-linear dynamics of equatorial and low-latitude ionosphere. These are listed below:

1. On p 1960, lines 13-14 are incorrect. In the dip equatorial region and at the low dip latitudes (all below 3.5 degrees) where the stations considered by the authors are located, the magnetic field  $B$  is horizontal and perpendicular to the dip equator and not parallel to the equator as stated by the authors.

2. On p 1960, lines 14-17: ‘Off the equator map along F region .....’ are meaningless. What do the authors mean by ‘the eastward electric field ( $E$ ) of the E-region interacts with the magnetic field  $B$  during the day’? There is no  $E \times B$  drift of the E region plasma as a whole because in the E region only the electrons are magnetized while ion motion is influenced more by collisions with neutrals.

3. On p1864, the authors fail to mention what the set  $u_i$  consists of and how do they obtain this set. Moreover,  $T_i$  in equation (3) is not the diurnal variation reduced time.
4. Authors fail to mention the formulae they have used to calculate the mutual information and the number of false nearest neighbours.
5. What does the delay representation of the time series shown in Figure 5 represent?
6. What are  $\Delta x$  and  $r$  in Equation (5)?
7. In equation (6), limit has to be calculated for  $r \rightarrow 0$  , and not  $r \rightarrow \infty$ .
8. Instead of the lengthy write-up on Tsallis Entropy, which has been better described in cited references, the authors should mention the formula that they have used to calculate the Tsallis Entropy from their data.
9. Equation (14) is incorrect and need not be given. Authors should write Eq. (15) correctly: they are summing over  $i$  and  $x$  is characterized by  $n$ ? The authors should take greater care to write correct equations.
10. Page 1876, lines 1-2. There is no such thing as ‘acoustic motions of the atmosphere electromagnetic emission’!
11. On p 1876, line 23. The solstices are not necessarily months of low solar activity. Some major magnetic storms have occurred during the solstices.

## 2. AUTHORS RESPONSE TO COMMENTS

We appreciate the referee’s comment there are other external influences is other than magnetospheric forcing seen during magnetic storms but also significant forcing from below the ionosphere. We like to state that this was considered by the authors but it was silent in the write up for instance gravity waves were meant to be mentioned as part of the influences on the internal dynamics of the ionosphere. Thank you for the comment necessary additions will be made.

1. Please refer to references for proper clarification on the direction of B field close to the equator.
2. The comment was right E X B drift only in the F region; necessary corrections will be effected in the main paper where necessary.
3. Please refer to other cited literatures where such techniques have been used.
4. Please refer to all given references on the techniques of embedding and phase space reconstruction.

5. Please refer to all given references on the techniques of embedding and phase space reconstruction.
6. Please refer to the reference (Wolf et al 1985) on the computation of Lyapunov exponents.
7. Lyapunov exponents should be computed for  $r \rightarrow \infty$ . Please refer to the reference (Wolf et al 1985) on the computation of a Lyapunov exponents
8. The write up was necessary as it gives relationship between Lyapunov exponent Tsallis entropy as recommended by previous referees in the previous paper since both parameters are being used together and also comparatively. The mathematical expressions describing the Tsallis entropy have been given in the text please consult referees for further understanding.
9. The equations are necessary, (14) is the basic moving average method equation and the correct equations are

$$u[t] = z[t] * w[n] = \frac{1}{2k+1} \sum_{i=-k}^k x[n-i]. \quad (14)$$

$$u[t] = z[t] * \omega[n] = \frac{\sum_{i=-k}^k A_i * x[n-i]}{\sum_{i=-k}^k A_i} \quad (15)$$

Refer to literatures.

10. Please see reference and other Literatures like the Physics of the ionosphere and magnetosphere by John Ashworth Ratcliffe to understand the concept of acoustic motions in the upper atmosphere.
11. Yes you are right there can be major storms in solstice on that point. However, many literatures have proven that the effect of solar wind and activities on the earth are usually higher during the equinoxes. The statement can be rephrased.

We appreciate the referee's comments and we shall look into a few points we find relevant but we will need the referee to refer to literatures where necessary. Thank you.

### 3. AUTHOR'S CHANGES TO MANUSCRIPT

- I. The authors will mention external factors from below the ionosphere in the published paper
- II. More clarity will be shown comment 2 based on the fact that the field due to the dynamo in the E-region maps along the magnetic field to the F region altitudes above the equator.
- III. Typographical errors in equations 14 and will be corrected
- IV. Comment 11 will be looked into statement will be suitably rephrased with editors consent

The authors hereby state that the additions and inclusion will be subject to editor's recommendations