

Reviewer Comments

Manuscript Title

Nocturnal variability of total electron content (TEC) at Koudougou (Burkina Faso) during three geomagnetic storms of solar cycle 24: Implications for equatorial ionospheric irregularities

General Comments

In other words, the title can be interpreted as follows:

How does the ionospheric total electron content (TEC) above Koudougou evolve during the night under the influence of three geomagnetic storms, and what do these variations reveal about the development of equatorial ionospheric irregularities that may disrupt GNSS systems and radio communications?

According to the authors, the main objectives of this work are to:

- characterize the nighttime TEC response at Koudougou during geomagnetic storms;
- identify the dominant electrodynamic mechanism (PPEF or disturbance dynamo) during SSC geomagnetic storms;
- explain the physical factors responsible for the different behaviors observed during the three storm events.

What makes this study potentially original?

This work focuses on a poorly documented region, namely West Africa, and more specifically Koudougou (Burkina Faso). This region remains significantly less studied than Brazil or India with respect to the ionospheric response to geomagnetic storms. Consequently, high-quality GNSS observations from Koudougou represent an important regional contribution.

Most previous studies have investigated the overall TEC response during geomagnetic storms. In contrast, the present study specifically examines the nighttime evolution of TEC, particularly during the post-sunset period (20:00–05:00 LT), when equatorial plasma bubbles are most likely to develop. This addresses a more focused and scientifically relevant problem.

The principal scientific contribution of this work is that **nighttime δTEC and σTEC together provide a practical diagnostic for distinguishing PPEF-dominated and disturbance dynamo-dominated electrodynamic regimes over the West African equatorial ionosphere, thereby providing indirect evidence of conditions that are either favorable or unfavorable for the development of equatorial ionospheric irregularities.**

However, the manuscript requires substantial revision before it can be considered for publication.

Although the proposed interpretation is physically plausible, the manuscript never demonstrates that ionospheric irregularities actually occurred. Rather, the study identifies signatures that are consistent with the development or suppression of irregularities without directly observing them. This distinction should be clearly stated throughout the manuscript, particularly in the discussion and conclusion.

Furthermore, the title refers to "**implications for equatorial ionospheric irregularities,**" yet the manuscript does not explain why σTEC can be considered a reliable indicator or proxy for ionospheric irregularities. The physical relationship between σTEC and plasma irregularities should be explicitly justified and supported by appropriate references.

The discussion devotes considerable attention to the respective roles of the PPEF and the disturbance dynamo. However, it does not sufficiently address the central scientific question raised by the title:

What have we learned about nighttime equatorial ionospheric irregularities over West Africa?

The discussion should place greater emphasis on the scientific implications of the observed nighttime TEC signatures for the occurrence or suppression of ionospheric irregularities rather than primarily describing the electrodynamic mechanisms.

In addition, the study is explicitly devoted to **nighttime TEC variability**, yet several analyses and figures extend over the entire 24-hour storm interval. Since equatorial plasma bubbles predominantly develop after sunset, the authors should justify why a full-day analysis is necessary or, preferably, focus their detailed interpretation on the nighttime period relevant to the stated objectives.

Finally, the conclusion is too brief. It should more clearly highlight the scientific contributions of the study, explain how the results advance our understanding of the nighttime equatorial ionosphere over West Africa, and explicitly answer the scientific question posed in the title.

Specific Comments

Typographical and Presentation Issues

The appropriate label in terms of LT is HH:MM not NNH as the authors did it in most of the figures. The x-axis labels are missing in Figures 3(a–e).

The figure captions should be revised and written in clear, standard scientific English.

The same comments apply to Figures 4 and 5, particularly Figure 5(a).

Scientific Comments

Lines 60–62

> "The vertical total electron content (VTEC) data come from the GPS receiver at Koudougou (dip: +8.24°), installed in December 2008 within the framework of the International Heliophysical Year (IHY) with the support of ENST-Bretagne. This station is part of the equatorial SCINDA network."

The authors state that the receiver used in this study was provided by ENST-Bretagne and that it is part of the SCINDA (Scintillation Network Decision Aid) network.

This statement is not entirely accurate. The SCINDA network was fully funded by the U.S. Air Force Research Laboratory (AFRL) through its partnership with Boston College. ENST-Bretagne contributed to the installation of some GPS receivers but was not responsible for the establishment or funding of the SCINDA network itself.

Magnetic Latitude and EIA

The manuscript states:

"Koudougou is in West Africa at geographic coordinates 12°15'N, 2°20'W. Its magnetic latitude, calculated with the IGRF-13 model, is approximately 2°N, placing it in the immediate vicinity of the foot of the northern crest of the equatorial ionization anomaly (EIA). The station is under the direct influence of the African equatorial electrojet, conferring on this position a high sensitivity to variations in the equatorial vertical E×B drift."

How can a station located at approximately **2°N magnetic latitude** be considered to be in the vicinity of the **northern crest of the Equatorial Ionization Anomaly (EIA)**? The northern EIA crest is typically located around **±15° magnetic latitude**, which, in the African sector, corresponds approximately to the latitude of Tamanrasset (southern Algeria). This statement should therefore be revised and scientifically justified.

Suggestions for Improving the English

Abstract

****Lines 15–18****

Current:

> "...with σ TEC classified as moderate to reduce during the main phase..."

Suggested:

> "...with σ TEC classified as moderate to low during the main phase."

****Lines 22–23****

Current:

> "...generation/suppression duality of nocturnal ionospheric irregularities..."

Suggested:

> "...dual role in the generation and suppression of nocturnal ionospheric irregularities."

****Lines 23–24****

Current:

> "...the antagonistic role of PPEF and the disturbance Dynamo."

Suggested:

> "...the antagonistic roles of PPEF and the disturbance dynamo."

Introduction

Line 43

Current:

> "...PPEF and disturbance Dynamo signatures."

Suggested:

> "...PPEF and disturbance dynamo signatures."

Lines 49–50

Current:

> "...offers a geophysically particularly suitable position..."

Suggested:

> "...offers a particularly suitable geophysical location..."

Lines 55-57

Current:

> "...identify the dominant signature mechanism (PPEF and disturbance Dynamo)..."

Suggested:

> "...identify the dominant electrodynamic mechanism (PPEF or disturbance dynamo)..."

Data and Methodology

Lines 72-74

Current:

> "...analyse the electrodynamic mechanisms responsible for ionospheric disturbances..."

Suggested:

> "...analyze the electrodynamic mechanisms responsible for ionospheric disturbances..."

****Lines 100–102****

Current:

> "...electron enhancement, typically associated with the PPEF..."

Suggested:

> "...an electron enhancement, typically associated with PPEF..."

Results

****Lines 132–134****

Current:

> "...indicating that the Koudougou station presents strong nocturnal irregularity activity..."

Suggested:

> "...indicating that the Koudougou station exhibits strong nocturnal irregularity activity."

****Lines 139–140****

Current:

> "...These curves serve as quiet reference..."

Suggested:

> "...These curves serve as a quiet-time reference."

****Lines 151-152****

Current:

> "...consistent with suppression of ionospheric irregularities..."

Suggested:

> "...consistent with the suppression of ionospheric irregularities."

****Lines 162-164****

Current:

> "...during J+1 recovery..."

Suggested:

> "...during the recovery day (J+1)."

****Lines 174–176****

Current:

> "...reflecting persistent intense ionospheric irregularity activity, the signature of a dominant PPEF."

Suggested:

> "...reflecting persistent intense ionospheric irregularity activity, consistent with the influence of a dominant PPEF."

Discussion

****Lines 202–203****

Current:

> "...this disturbing electric field..."

Suggested:

> "...this disturbance electric field..."

****Lines 220–222****

Current:

> "...without explicitly distinguishing PPEF and disturbance Dynamo regimes."

Suggested:

> "...without explicitly distinguishing PPEF and disturbance dynamo regimes."

Conclusion

****Lines 227–229****

Current:

> "...dominated by the disturbance Dynamo..."

Suggested:

> "...dominated by the disturbance dynamo."

****Lines 232–233****

Current:

> "...illustrating the temporal succession of PPEF and disturbance Dynamo."

Suggested:

> "...illustrating the temporal succession of PPEF and the disturbance dynamo."