

## Referee Report

I am pleased to recommend the acceptance of this manuscript for publication after minor technical revision. The study presented by the author significantly advances our understanding of the relationship between geospace storms and substorm current wedge formation. By analyzing data from the INTERMAGNET magnetometer network, the author effectively demonstrates the latitude dependence of geomagnetic field variations during the severe geomagnetic storm that occurred on 23-24 April 2023. This innovative approach provides valuable insights into energy transfer processes between the ionosphere and magnetosphere, highlighting the complexities of geosphere interactions.

The author has well organized the content structure of the article, clearly presenting the background, methods and results of the research, so that readers can smoothly understand the core ideas of the research. The experimental design of the paper is reasonable. By analyzing the severe geomagnetic storm data from April 23 to 24, 2023, it reveals the relationship between the change of the geomagnetic field and the formation of the substorm current wedge, which has important scientific value. At the same time, the data analysis in the paper is based on the INTERMAGNET magnetometer network (open data sources), which enhances the reliability and repeatability of the research.

The manuscript's strength lies in its rigorous analysis of geomagnetic fluctuations across different hemispheres, which reveals crucial threshold conditions for substorm current wedge formation. The identification of  $B_z$  values ranging from  $-(22-30)$  nT as critical for wedge formation significantly contributes to the existing body of knowledge regarding geomagnetic disturbances. Additionally, the paper successfully contextualizes its findings within the broader literature on space weather, laying the groundwork for future research in this area.

While the manuscript is well-crafted, I believe there are some areas where further refinement could strengthen its impact. For instance,

- it may be beneficial for the authors to explore the broader implications of their findings for space weather forecasting and how they may affect technological systems.
- Additionally, including a discussion that situates their work within the context of previous research on geomagnetic storms could help emphasize the contribution of their study to the field (The author have indeed discussed a substantial body of literature in the introduction, I just recommend the author do it in more detail in discussion, to make a more comprehensive comparison, if possible).

To further enhance the manuscript, I would appreciate the opportunity to discuss a few questions/possibilities with the author:

- Maybe the identified critical  $B_z$  values contribute to future space weather prediction efforts?
- Have the authors considered other factors, such as Seasonal Effects, that may influence the formation of substorm current wedges?
- I am interested in the author's future research plan in this topic. Because I noticed the author has a lot of experience in this research direction. If the author is willing to give some discussion or suggestions in this regard, it will be very helpful and inspiring to scholars and readers in the same industry.

I look forward to engaging with the authors on these points and contributing to the improvement of this important work. Overall, I commend the author for this important contribution and look forward to the minor technical revisions that will enhance its clarity and relevance.