

We sincerely thank you for your thorough and insightful review of our manuscript. We truly appreciate the time and care you devoted to evaluating our work, as well as your many helpful comments, suggestions, and corrections.

Your feedback has helped us to clarify important points and improve the overall quality and precision of the manuscript. Below, we provide detailed responses to each of your specific comments, along with a description of the corresponding changes we have made.

Referee comment 1:

The peer review of data described in the paper is new to the magnetic observatory community and is of such significance it and might be worth emphasising by adding “by peer review” to the title?

Reply:

Thank you for your suggestion. We have carefully considered this suggestion. Although we have not yet decided on the final title, one option we are currently considering is: “INTERMAGNET's peer-reviewed efforts to improve the quality and availability of 1-minute Definitive Data.”

Author's final changes:

“The INTERMAGNET framework for peer-review and activities for improvement of 1-minute Definitive Data quality and availability”

Referee comment 2:

Is there a better word than “delayed” (line 10). The idea is different levels of data scrutiny or quality control; very little for real-time data; ‘some’ for QD and a great deal for DD. “delayed” sounds rather negative as if there’s a problem, perhaps use ‘quality controlled’ instead

Reply:

The word "delayed" was replaced with "post-processed," which seems like a better word in this context.

Author's changes:

The relevant changes can be found in line 11.

Referee comment 3:

Definitive Data sets are intended to be final, although, very occasionally, circumstances arise where revisions are justified. It would be worth mentioning this more explicitly, including examples of the circumstances where changes might be warranted.

Reply:

We have added the following clarification in Chapter 4:

Corrections are very rare. However, occasional updates may be applied to both the one-minute average data files and the accompanying auxiliary files. Such corrections may result from, for example, errors discovered in baseline determination, mistakes in metadata (such as incorrect observatory coordinates), or the publication of incorrect annual means in yearmean-type files.

Author's changes:

The relevant changes can be found in lines 151-154.

Referee comment 4:

The authors use the word “homogeneity” (Line 190). It would be helpful for them to explain clearly what is meant by this term in the context of the paper.

Reply:

When using the term homogeneity, the authors refer to the consistency and uniformity of geomagnetic field measurements over time. This means that any variations in the data should reflect real changes in the Earth's magnetic field, rather than being caused by measurement errors, changes in equipment, calibration issues, or differences in procedures at individual observatories.

An explanatory sentence will be added at the point where the term homogeneity appears:

“In this context, homogeneity means that variations in the data from the network of observatories should reflect true changes in the Earth's magnetic field, rather than being caused by measurement errors, equipment changes, poor calibration, or inadequate measurement procedures at individual observatories.”

Author's changes:

The relevant changes can be found in lines 217-219.

Referee comment 5:

The authors abbreviate Definitive Data as DD, whereas Quasi-Definitive Data is referred to as QD. In the manuscript “DD data” is discussed that would mean Definitive Data data (e.g. Line 15). Should Quasi Definitive Data be abbreviated to QDD? Alternatively in instances where “...QD and DD data...” appear the order should be changed to “...DD and QD data ... “to remove the duplication of the word ‘data’.

Reply:

The abbreviation QDD suggested by the reviewer is indeed more logical. However, the abbreviation QD is the one commonly used in the geomagnetic community. Introducing a new abbreviation specifically for this article might cause confusion. That said, we truly appreciate the reviewer’s suggestion and will follow their advice by changing the sequence from “QD and DD” to “DD and QD”.

Author's changes:

The abbreviations are defined in line 12. Changing the sequence is in line 17.

Referee comment 6:

The authors refer to the process of “Call for Data” (Line 99). It would be helpful for the reader to explain briefly what this process is.

Reply:

The following text will be added to Chapter 3:

The "Call for Data" is an annual message sent by INTERMAGNET to observatories after the end of the calendar year. It provides the deadline for submitting Definitive Data, along with key information about data requirements, including the list of mandatory files and where to upload them (usually the Paris GIN FTP server). The message also highlights any changes in data standards or submission procedures compared to the previous year.

Author's changes:

The relevant changes can be found in lines 104-107.

Minor Comments and Corrections

1. With an acronym DD it could be better to capitalise Data in “Definitive data”?

“Definitive data” is used throughout the text and the authors should check consistency in their use of “DD” or “Definitive data”.

Reply: has been corrected

Author's changes: checked and corrected if needed.

2. Line 33: “However, while their ...”

Reply: has been corrected

Author's changes: the relevant change in line 35

3. Line 36: Change “Delayed Data” to “Quality controlled ...” as suggested above. It would also make sense to change the order of DD and QD bullet points since QD is available before DD.

Reply: has been corrected

Author's changes: the relevant changes can be found in line 11, the word "delayed" was replaced with "post-processed"

4. Line 40: Is “magnetologist” commonly used? I might substitute “scientists”.

Reply: has been corrected

Author's changes: see line 42

5. Line 42: Definitive Data is referred to DD, similarly, should Quasi-Definitive Data be referred to as QDD?

Reply: The abbreviation QDD is logical, but no changes for the reasons explained earlier.

Line 69: “Baseline plots analysis...” change to “Analysis of baseline plots ...”

Reply: has been corrected

Author's changes: see line 72

6. Line 74: "... requirements are outlined ..."

Reply: has been corrected

Author's changes: see line 78

7. Line 76: "...datasets..."

Reply: changed to "Definitive Data sets"

Author's changes: see line 80

8. Line 86: "...components and ..."

Reply: has been corrected

Author's changes: see line 90

9. Line 95: "...benefiting all ..."

Reply: has been corrected

Author's changes: see line 99

10 Line 100: "...Data Checking Task Team members..."

Reply: has been corrected

Author's changes: see line 108

11. Line 110: In "IAF format", spell out the acronym IAF.

Reply: has been corrected

Author's changes: see line 120

12. Line 111: "...1-minute data series "

Reply: has been corrected

Author's changes: see lines 120-121

13. Line 111: "... K local magnetic activity index..."

Reply: has been corrected

Author's changes: see line 121

14. Line 116: "K9- limit for the local magnetic activity index"

Reply: has been corrected

Author's changes: see line 126

15. Line 121: "K index values"

Reply: The line was removed because K values were mentioned few lines earlier.

Author's changes: the relevant change (delete) around line 130

16. Line 123: “The file with the BLV extension”

Reply: has been corrected

Author's changes: see line 132

17. Line 124: ”...and adopted baselines. The Yearmean file contains ...”

Reply: has been corrected

Author's changes: see line 133

18. Line 129: replace “like” by “such as”.

Reply: has been corrected

Author's changes: see line 142

19. Line 130: Incorrect spelling of “magnetometer”.

Reply: has been corrected

Author's changes: see line 142

20. Line 130: “... visually comparing plots of the time ...”

Reply: has been corrected

Author's changes: see line 143

21. Line 140: “...tools have...”

Reply: has been corrected

Author's changes: see line 156

22. Line 141: “...converting formats...”

Reply: has been corrected

Author's changes: see line 157

23. Line 156: “...INTERMAGNET-DKA”

Reply: has been corrected

Author's changes: see line 173

24. Line 190. “The Data Checking Task Team (DCTT)...”

Reply: After editing the Conclusion, only the abbreviation DCTT was used.

Author's changes: see line 213

Reply on RC2 of 24 Jul 2025 (anonymous)

We would like to sincerely thank you for your constructive and generally positive review of our manuscript. We greatly appreciate the time and effort you invested in providing detailed feedback, including the valuable annotations made directly in the reviewed manuscript file.

In some cases, we were not entirely sure how to interpret certain highlights or markings in the annotated file, as they were not always accompanied by specific comments. Nevertheless, wherever your intention was clear for us, we have made the appropriate revisions.

Below is a list of the changes we have made in response to your comments.

Referee note, line 44:

What do you mean by 'relevant'? Be more specific.

Reply:

The revised sentence with the word "relevant" now reads: „They are particularly relevant for the Swarm satellite mission (Macmillan and Olsen, 2013), as QD data are almost as accurate as Definitive Data but are available much earlier.”

Author's changes:

The relevant changes can be found in lines 46-47.

Referee note, line 98:

The following link is much more pertinent: <https://intermagnet.org/structure.html#data-checking-task-team>.

Reply: has been corrected

Author's changes: see line 102

Referee note, line 100:

Data Checking Team -> DCTT

Reply: has been corrected

Author's changes: see line 108

Referee note, line 104:

Add descriptions to X, Y, Z and G. Particularly, G isn't familiar to non-experts of Intermagnet

Reply:

The revised sentence is the following: “Twelve final 1-minute binary data files (*.bin), oriented XYZG where: X (north), Y (east), Z (vertical), and G is the difference between vector and scalar observations”

Author's changes: see lines 112-113

Referee note, line 110:

Add an explanation for IAF format or make a link to the relevant page of your latest Technical Manual v5.2.

Reply:

The revised sentence is the following: “Most are binary files, in INTERMAGNET Archive Format (IAF), as described in the Technical Manual (St-Louis et al., 2020), containing 1-minute data series of the XYZG geomagnetic field or K local magnetic activity index, along with essential metadata, such as:”

Author's changes: see lines 119-122

Referee note, lines 111, 116:

Explanation for what is K9-limit as well as K values themselves.

Reply:

A citation of the following work has been added: Menvielle, M., & Berthelier, A. (1991). The K-derived planetary indices: Description and availability. *Reviews of Geophysics*, 29(3), 415–432. <https://doi.org/10.1029/91RG00994>

Author's changes: see lines 121,126

Referee note, lines 126:

What do you mean by this sentence? If you are to say that there're still problems in Intermagnet metadata, describe them in detail.

Reply:

It would be difficult to include all possible inconsistencies in the article. However, we have expanded on the idea presented in that sentence:

An important aspect of quality control for geomagnetic data provided by INTERMAGNET observatories is the detection of inconsistencies within the dataset. This is particularly relevant because certain metadata, such as geographic coordinates, appear in several files of the dataset. One common issue is a discrepancy between 1-minute time series data and the annual averages contained in the yearmean file. Inconsistencies may also occur within the yearmean file itself - for example, between the X (north), Y (east), and H (horizontal) components. Many other types of discrepancies are also possible.

Author's changes: see lines 135-139

Referee note, line 129:

This should be a squared sum of X, Y and Z. Be consistent in your notation throughout your manuscript.

Reply:

has been corrected

Author's changes: see line 141

Referee note, line 156:

Give pertinent links to IMFV and DKA in Technical Manual. If not, give explanations for each here.

Reply:

A sentence with a citation to the INTERMAGNET Technical Reference Manual was added here. This part of the text now looks as follows:

A Java application for converting between various geomagnetic data formats: WDC, IMFV, IAGA2002, ImagCDF, and INTERMAGNET-DKA. Definitions of these formats, particularly those used by INTERMAGNET, can be found in the INTERMAGNET Technical Reference Manual (St-Louis et al., 2020). The application can operate in both graphical and command-line modes.

Author's changes: see line 172

Referee note, line 173:

Add description to DF.

Reply:

Now the figure caption is as follows. Fig. 2. MagPy. Graphical visualization of XYZ for one month (here for Conrad Observatory WIC, DF=F-S).

Author's changes: see line 197

Referee note, line 185:

This is good. However, it may lead to many DOIs that rob transparency for data users. Do you have any routines that convert multiple DOIs to a single annual DOI?

Reply:

The idea is to have a single DOI. New data will continue to be added under this DOI over time. In practice, the same DOI will cover all INTERMAGNET Definitive Data sets from 1991 up to the most recently submitted and accepted data.

Author's changes: see line 207, no changes

Referee note, line 190:

Data Checking

Reply:

It was corrected by using the abbreviation DCTT that was introduced earlier.

Author's changes: see line 213

Reply on RC3 of 18 Jul 2025 (Kristina Rossavik)

We would like to sincerely thank you for your careful reading of our manuscript and for your thoughtful and constructive comments. We are pleased to know that you found the scientific approach and presentation satisfactory.

Below, we address each of your specific suggestions aimed at improving the clarity and completeness of the paper. We appreciate your input and have made revisions accordingly.

SPECIFIC COMMENTS

Referee comment 1:

It may be helpful to describe more the equation for F_v or provide a citation (Line 129). I think it refers to F that is formed by X , Y , and Z from the vector magnetometer. Following the equation for F_v , something could be said such as, “where x , y , and z are recorded by the observatory’s vector magnetometer, and F_s , which is recorded by an absolute scalar field magnetometer like a proton or Overhauser magnetometer. “

Reply:

Thank you for the suggestion. The text around line 129 now reads as follows. When reviewing 1-min data time series, the visual assessment of the magnetic field recordings is a key step to detect discrepancies between F ($F = \sqrt{X^2 + Y^2 + Z^2}$) and S , where X , Y , and Z are recorded by the observatory’s vector magnetometer, and S , which is recorded by an absolute scalar field magnetometer like a proton or Overhauser magnetometer.

Author's changes: see lines 140-144

Referee comment 2:

From Lines 108 and 109, I do not know if those are required or optional elements. Maybe it could be mentioned if they are optional, as well as what would be in the country read me file.

Reply:

It's true that one might wonder whether these files are required or simply recommended. INTERMAGNET continues to collect them from observatories, which is relatively easy when all observatories in a given country are managed by the same parent institution. In this article, however, we prefer not to go into this topic in detail.

Author's changes: see lines 117-118, no changes

Referee comment 3:

May be helpful to include citations around Line 121 regarding K values or description of the term.

Reply:

A citation has been added to the local K index and the K_9 -limit:

Menvielle, M., & Berthelier, A. (1991). The K -derived planetary indices: Description and availability. *Reviews of Geophysics*, 29(3), 415–432. <https://doi.org/10.1029/91RG00994>

Author's changes: see lines 121, 126

Referee comment 4:

The paper has several enlightening statements such as that found in line 95 (related to the incredibly beneficial exchange of ideas) or line 39 (encouraging use of backup data when available), and lines 60-70 which explain the value of baseline plots and how they may be affected. It may be a nice place to further elaborate upon, or cite where to find, the criteria of what is considered the best, and/ or what is acceptable, when analysing the differences between baselines and data.

Reply:

Thank you for your kind comments. As for the suggestion to expand on the topic of baselines, this is indeed quite a broad subject, and it would be difficult to cover it in more detail within the scope of this article. We believe it would be better suited for a separate publication. For that reason, we have added a sentence with a reference to the IAGA Guide (Jankowski, J., and C. Sucksdorff, 1996, Guide for Magnetic Measurements and Observatory Practice, Int. Assoc. of Geomagn. and Aeron., Warsaw), where this topic is addressed in several places. The added sentence reads as follows:

"A guide published by IAGA includes numerous references to the evaluation of baselines and their role in observatory practice (Jankowski and Sucksdorff, 1996)."

Author's changes: see lines 73-74

TECHNICAL CORRECTIONS

Line 33: Suggestion for sentence rearrangement: "Their low latency offers rapid availability, however they are not yet fully calibrated.."

Reply: has been corrected

Author's changes: see line 35

Line 33: Suggestion to add 'purposes' after 'operational monitoring'

Reply: has been corrected

Author's changes: see line 36

Line 42: Capitalization of the word 'provided'

Reply: has been corrected

Author's changes: see line 44

Line 43: Replace the comma after the word 'recording' by a period.

Reply: has been corrected

Author's changes: see line 45

Line 74: Remove extra parenthesis in "..the Technical Manual ((St-Louis et al., 2020),"

Reply: has been corrected

Author's changes: see line 78

Line 80: Capitalization of 'data' in "Definitive data"

Reply: has been corrected

Author's changes: see line 84

Line 81: Remove 's' from "volunteers" such that it reads "volunteer experts" or switch the words around: "expert volunteers".

Reply: has been corrected

Author's changes: see line 85

Line 86: Remove the space between 'but also includes' and the colon. The sentence could also be written,

"The review process extends beyond analyzing the time series of geomagnetic field components, and also includes:

or

"The review process extends beyond the analysis of the time series of geomagnetic field components, and also includes:"

or

"The review process extends beyond analyzing the time series of geomagnetic field components. It also includes: "

Reply: We followed the first suggestion.

Author's changes: see lines 89-90

Line 126: Remove the 's' from the word 'appears'.

Reply: has been corrected

Author's changes: see line 136

Line 130: Capitalize the 'o' in 'overhauser magntoemter' and check spelling of magnetometer.

Reply: has been corrected

Author's changes: see lines 141, 142

Line 130: Suggestion for sentence rearrangement: "In addition, visual comparisons of the time series of a given observatory with those from neighboring observatories often provide valuable insights."

Reply: We used the suggestion. Thank you.

Author's changes: see lines 142-144

Line 136: Remove comma after link ("..._dois,")

Reply: has been corrected

Author's changes: see line 149

Line 137: Suggestion for sentence rearrangement: “Dating back to 1991, it contains the most recent data updates for the entire INTERMAGNET network, along with time series, baselines, K indices,...”

Reply: We used the suggestion. Thank you.

Author's changes: see lines 150-151

Line 140: Replace ‘has’ with ‘have’ (“...various software tools have been developed...”)

Reply: has been corrected

Author's changes: see line 156

Line 143: Remove the space between the link and the comma (“...html ,”)

Reply: has been corrected

Author's changes: see line 159

Line 181: Suggestion of adding the word ‘to’ between ‘leading’ and ‘the’, and remove the word ‘a’ between ‘of’ and ‘condensed’, i.e.: “...leading to the elaboration of condensed, standardised guidelines..” Or, “ Volunteers from the Data Checking Task Team (DCTT) are adopting improved workflows which lead the elaboration of condensed, standardised guidelines..”

Reply: We used the suggestion (option 2). Thank you.

Author's changes: see lines 203-204

Associate Editor remarks of June 20, 2025

The article presents the INTERMAGNET peer-reviewed geomagnetic observatory definitive data process. An important process that ensures high quality data for the geomagnetic community. The article fits very well to the special issue "Geomagnetic observatories, their data, and the application of their data", and is well structured and presented. It is ready for review and discussion. However, I have a few suggestions for very minor technical corrections that the authors may wish to consider.

Line 55: add “.” in the end of the sentence

Reply: Done

Author's changes: see line 58

Line 84, 180 and 190: DCTT already defined in line 81 (revised version)

Reply: DCTT introduced 1-st time in line 85,

Author's changes: see lines 85, 88, 101, 108, 147, 203, 213

Line 129: F_x , F_y and F_z is introduced here, I suggest replacing with X , Y and Z for consistency

Reply: Now X , Y , Z , S is introduced

Author's changes: see lines 141-142

Line 190: DD already defined on line 37

Reply: Now DD and QD is defined

Author's changes: see line 12

Line 197: Please only use initials instead of full author names in this section

Reply: Done

Author's changes: see lines 222-223