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Preparation of Papers for IEEE OPEN JOURNALS

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ABSTRACT These

INDEX TERMS Enter key words or phrases in alphabetical order, separated by commas. For a list of suggested keywords, send a blank e-mail to keywords@ieee.org or visit http://www.ieee.org/organizations/pubs/ani_prod/keywrd98.txt

I. INTRODUCTION

SPACE Space weather is the phenomenon of solar storms and other events in space that can have an impact on Earth. The main source of space weather is the Sun, which can produce solar flares [1]–[4], coronal mass ejections (CMEs) [5]–[8], and high-speed solar wind streams that cause significant impacts on modern society [9], affecting technologies such as radio communication, GPS and GNSS systems, and satellite communications, high-latitude aviation, mining operations, power grids, and natural gas pipelines [10], [11]. The results can disrupt radio communications, endanger astronauts, cause errors in GPS and GNSS systems, lose satellite communications, expose pilots and passengers to higher levels of radiation in high-latitude aviation, overload power grids, and accelerate corrosion of natural gas pipelines [12]. As a result, space weather has significant implications for national security due to the capability to damage critical infrastructures, such as the electric grid. The US has a large space-based infrastructure and is almost exclusively reliant on an aging and stressed power grid, making it vulnerable to the effects of space weather. To mitigate these effects, the US has established a Federal Operating Concept for Impending Space Weather Events [13], which focuses on operational and crisis planning. Space weather study has become one of the most important research fields in recent years.

Geostorms result in anomalies and disruptions to modern conveniences such as electrical power distribution networks. Space weather conditions on the ground generally originate from the interaction of the solar wind with the magnetosphere, which propagates down to the ionosphere and ground via magnetic field lines [14]. Geomagnetically induced currents (GICs) are set up by a geoelectric field (E) which arises from time variations in magnetic field B caused by ionospheric and magnetospheric currents and the conductive properties of the ground. The GICs can cause severe damage to power grids. Extreme space weather events are now recognized as a serious threat to worldwide technological infrastructure, e.g., [15], [16]. For example, during the 1989 storm [17], the entire grid was out of service within 90 seconds. The collapsed power grid left six million people and the rest of Quebec without electricity for nine hours in most places, and days in others. This geomagnetic storm caused about \$10 million dollars in damage to Quebec and tens of millions of customers out of service. Extreme geomagnetic disturbances (GMDs) during the storm can be generated with a variety of spatial scales. They can occur in the auroral zone with fine spatial scales ($<\sim$100 km) or be excited by CMEs [18] and interplanetary shocks with global scales [19]–[21]. Magnetometers have proven essential in this area for both research and real-time monitoring of B that drives GIC. Forecasting large GIC remains challenging as the largest GIC is not always concurrent with the largest geomagnetic depressions [22], [23] or elevated geomagnetic activity levels [24]. So, it is important to use magnetometer observation to investigate the physics mechanism behind GICs and to verify the model predictions with observations [25]. Since the 2003 Halloween Storm is the most intense storm in recent three decades, It has been studied by many researchers with different focus, such as the geomagnetic disturbance at lowest latitudes in the dayside hemisphere [26], [27], the equatorial anomaly in the Brazilian sector [28], impacts on power grids at mid-latitudes [29], geoelectric hazard maps for the Mid-Atlantic United States [30], GICs on power network in New Zealand [31], in Brazil [27], in Spain [32], in Great Britain [33], in Scotland [34], and in Japan [35]. An insightful collection of research articles is listed in [36] and a Geophysical Monograph on GICs and their impacts on power systems is published by [37].

In this research paper, in order to assess the space weather impacts on power grids, the geomagnetic disturbances (GMDs) during the Halloween Storm is analyzed by using global maps of geomagnetic disturbances to find where it is received and how it propagated. To cover the global GMDs, there are GMD data from 205 geomagnetic observatories collected during the Halloween Storm, which makes it possible to draw a global picture of the storm's impacts on geomagnetic disturbances. The map is generated with Kriging interpolation then (mapping?). The maps show that impacts are received first in high-latitude regions and then propagate toward mid- and low-latitude regions. Examining magnetic field variations caused by this great storm at a global scale allows for a better understanding of the questions: How did the 2003 Halloween storm impact the regions of the Earth from the point of view of geomagnetic disturbances? How do different regions of the Earth are impacted differently? The answers to these questions will provide observational information during a solar storm to power grid operations and other crucial infrastructures [38]. It will help them to mitigate potential hazards caused by space weather. Also, by comparing the predicted value of geomagnetic disturbances to global maps, researchers will be able to assess the prediction's accuracy and how the model can be improved to achieve better and more accurate results.

In this research paper, the Model description and data used are presented in section 2; the results of global maps of GMDs during the storms are presented in section 3; a discussion and a summary of these results are concluded in section 4.

II. Data and Model Description

A. Data

For this research, the 2003 Halloween Storm was picked as it is the strongest solar storm 124 in the last three decades that impacted the Earth since one in 1989. The Halloween storm 125 lasted three days and had several waves of storms. Only the first two storms on October 126 29th, 2003 were selected due to the limited scale of research and data available on solar 127 wind conditions. Storm-1 is defined as the period between 06-09 UT based on the level of 128 Interplanetary Magnetic Field (IMF) based on observations from ACE Satellite and Sym-H 129 index shown in Figure 1. Storm-2 is defined as 17-24UT.

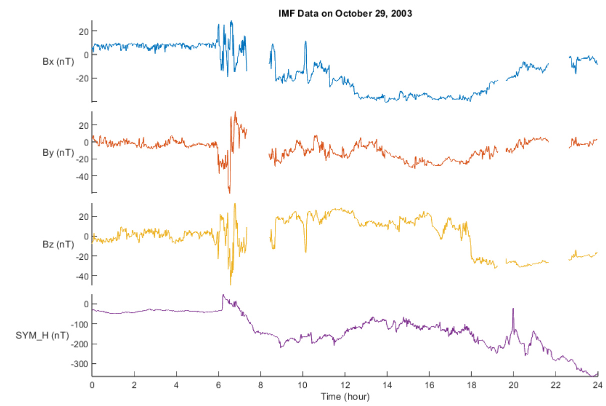

FIGURE 1. The missing data from the stacked plot is a result of extremely intense storms

Data with a time resolution of one minute and a time interval from 00:00 UT, October 29, 2003 to 1:00 UT, October 30, 2003 was downloaded from SuperMAG (supermag.jhuapl.edu). Stations containing more than 20 minutes of missing data at the beginning or end of each of the two identified storms (Storm-1: 05:09 - 09:09 UTC, Oct. 29, 2003; Storm-2: 17:24 UT, Oct. 29, 2003 - 00:24 UT, Oct. 30, 2003) are then removed due to the inaccurate interpolation results when linearly interpolating with an open end, which is when only one end to the period being interpolated is defined. This leaves 193 quality stations for Storm-1 and 188 for Storm-2. Solar wind data are from ACE satellites in the NASA database (https://sohoftp.nascom.nasa.gov/sdb/goes/ace/daily/) and the temporal resolution of which is 60 seconds. The Interplanetary Magnetic Field (IMF) data are split into three components in Geocentric Solar Magnetospheric (GSM) coordinate.

This data is then used to create the global maps of magnetic variations during the two defined storms, which are created with MATLAB. The mesh grid has a precision of 1. The base map loaded is the "landareas.shp" from the Mapping Toolbox^{TM} in MATLAB. The dBh values of the stations are calculated based on the dBn and dBe components. The signage of the value is then based on the signage of the dBn value (positive dBn means a positive dBh).

$$dBh = \sqrt{dBn^2 + dBe^2}$$

The dBh values are then interpolated with Kriging interpolation to generate a map, which is then overlaid on the base world map as a colormap with the MATLAB function mapshow(). The dBn and dBe component of each station are then used to plot the vector arrow where dBn represents the north-south (vertical) component and dBe represents the west-east (horizontal) component.

The map is in the Projected Coordinate System so the geocoordinates match the Cartesian coordinates. Although the interpolation relies on Cartesian coordinates rather than geocoordinates, which means data points near the poles are skewed, this limitation is not significant enough for the purpose of this study. The accuracy of interpolation by kriging will also be limited as the number of stations is spatially sparse.

The global map of the magnetic variations during the Halloween storm was generated with MATLAB, and the mesh grid was created with a precision of 1.

B. Model

add a flow chart of the code

III. UNITS

Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). This applies to papers in data storage. For example, write "15 Gb/cm^2 (100 Gb/in^2)." An exception is when English units are used as identifiers in trade, such as "3½-in disk drive." Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation.

The SI unit for magnetic field strength H is A/m. However, if you wish to use units of T, either refer to magnetic flux density B or magnetic field strength symbolized as $\mu_0 H$. Use the center dot to separate compound units, e.g., "A•m^2."

IV. SOME COMMON MISTAKES

The word "data" is plural, not singular. The subscript for the permeability of vacuum μ_0 is zero, not a lowercase letter "o." The term for residual magnetization is "remanence"; the adjective is "remanent"; do not write "remnance" or "remnant." Use the word "micrometer" instead of "micron." A graph within a graph is an "inset," not an "insert." The word "alternatively" is preferred to the word "alternately" (unless you really mean something that alternates). Use the word "whereas" instead of "while" (unless you are referring to simultaneous events). Do not use the word "essentially" to mean "approximately" or "effectively." Do not use the word "issue" as a euphemism for "problem." When compositions are not specified, separate chemical symbols by en-dashes; for example, "NiMn" indicates the intermetallic compound $Ni_{0.5}Mn_{0.5}$ whereas "Ni–Mn" indicates an alloy of some composition Ni_xMn_{1-x}.

Be aware of the different meanings of the homophones "affect" (usually a verb) and "effect" (usually a noun), "complement" and "compliment," "discreet" and "discrete," "principal" (e.g., "principal investigator") and "principle" (e.g., "principle of measurement"). Do not confuse "imply" and "infer."

Prefixes such as "non," "sub," "micro," "multi," and "ultra" are not independent words; they should be joined to the words they modify, usually without a hyphen. There is no period after the "et" in the Latin abbreviation "*et al.*" (it is also italicized). The abbreviation "i.e.," means "that is," and the abbreviation "e.g.," means "for example" (these abbreviations are not italicized).

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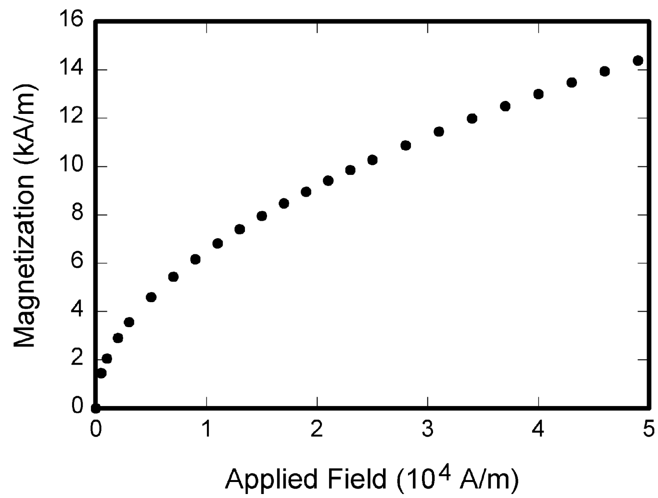

FIGURE 2. **Magnetization as a function of applied field. Note that "Fig." is abbreviated. There is a period after the figure number, followed by two spaces. It is good practice to explain the significance of the figure in the caption.**

V. GUIDELINES FOR GRAPHICS PREPARATION AND SUBMISSION

A. TYPES OF GRAPHICS

The following list outlines the different types of graphics published in IEEE journals. They are categorized based on their construction, and use of color / shades of gray:

1) Color/Grayscale Figures

Figures that are meant to appear in color, or shades of black/gray. Such figures may include photographs, illustrations, multicolor graphs, and flowcharts.

2) Line Art Figures

Figures that are composed of only black lines and shapes. These figures should have no shades or half-tones of gray, only black and white.

3) Author Photos

Head and shoulders shots of authors that appear at the end of our papers.

4) Tables

Data charts which are typically black and white, but sometimes include color.

TABLE 1. Units for Magnetic Properties

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI [a]
Φ	magnetic flux	1 Mx $\rightarrow 10^{-8}$ Wb $= 10^{-8}$ V·s
B	magnetic flux density, magnetic induction	1 G $\rightarrow 10^{-4}$ T $= 10^{-4}$ Wb/m^2
H	magnetic field strength	1 Oe $\rightarrow 10^3/(4\pi)$ A/m
m	magnetic moment	1 erg/G $=$ 1 emu $\rightarrow 10^{-3}$ A·m$^2 = 10^{-3}$ J/T
M	magnetization	1 erg/(G·cm^3) $=$ 1 emu/cm^3 $\rightarrow 10^3$ A/m
$4\pi M$	magnetization	1 G $\rightarrow 10^3/(4\pi)$ A/m
σ	specific magnetization	1 erg/(G·g) $=$ 1 emu/g $\rightarrow$ 1 A·m^2/kg
j	magnetic dipole moment	1 erg/G $=$ 1 emu $\rightarrow 4\pi \times 10^{-10}$ Wb·m
J	magnetic polarization	1 erg/(G·cm^3) $=$ 1 emu/cm^3 $\rightarrow 4\pi \times 10^{-4}$ T
χ, κ	susceptibility	$1 \rightarrow 4\pi$
χ_ρ	mass susceptibility	1 cm^3/g $\rightarrow 4\pi \times 10^{-3}$ m^3/kg
μ	permeability	$1 \rightarrow 4\pi \times 10^{-7}$ H/m $= 4\pi \times 10^{-7}$ Wb/(A·m)
μ_r	relative permeability	$\mu \rightarrow \mu_r$
w, W	energy density	1 erg/cm^3 $\rightarrow 10^{-1}$ J/m^3
N, D	demagnetizing factor	$1 \rightarrow 1/(4\pi)$

Vertical lines are optional in tables. Statements that serve as captions for the entire table do not need footnote letters.

[a]Gaussian units are the same as cg emu for magnetostatics; Mx $=$ maxwell, G $=$ gauss, Oe $=$ oersted; Wb $=$ weber, V $=$ volt, s $=$ second, T $=$ tesla, m $=$ meter, A $=$ ampere, J $=$ joule, kg $=$ kilogram, H $=$ henry.

B. MULTIPART FIGURES

Figures compiled of more than one sub-figure presented side-by-side, or stacked. If a multipart figure is made up of multiple figure types (one part is lineart, and another is grayscale or color) the figure should meet the stricter guidelines.

C. FILE FORMATS FOR GRAPHICS

Format and save your graphics using a suitable graphics processing program that will allow you to create the images as PostScript (PS), Encapsulated PostScript (.EPS), Tagged Image File Format (.TIFF), Portable Document Format (.PDF), or Portable Network Graphics (.PNG) sizes them, and adjusts the resolution settings. If you created your source files in one of the following programs you will be able to submit the graphics without converting to a PS, EPS, TIFF, PDF, or PNG file: Microsoft Word, Microsoft PowerPoint, or Microsoft Excel. Though it is not required, it is strongly recommended that these files be saved in PDF format rather than DOC, XLS, or PPT. Doing so will protect your figures from common font and arrow stroke issues that occur when working on the files across multiple platforms. When submitting your final paper, your graphics should all be submitted individually in one of these formats along with the manuscript.

D. SIZING OF GRAPHICS

Most charts, graphs, and tables are one column wide (3.5 inches / 88 millimeters / 21 picas) or page wide (7.16 inches / 181 millimeters / 43 picas). The maximum depth a graphic can be is 8.5 inches (216 millimeters / 54 picas). When choosing the depth of a graphic, please allow space for a caption. Figures can be sized between column and page widths if the author chooses, however it is recommended that figures are not sized less than column width unless when necessary.

There is currently one publication with column measurements that do not coincide with those listed above. Proceedings of the IEEE has a column measurement of 3.25 inches (82.5 millimeters / 19.5 picas).

The final printed size of author photographs is exactly 1 inch wide by 1.25 inches tall (25.4 millimeters x 31.75 millimeters / 6 picas x 7.5 picas). Author photos printed in editorials measure 1.59 inches wide by 2 inches tall (40 millimeters x 50 millimeters / 9.5 picas x 12 picas).

E. RESOLUTION

The proper resolution of your figures will depend on the type of figure it is as defined in the "Types of Figures" section. Author photographs, color, and grayscale figures should be at least 300dpi. Line art, including tables should be a minimum of 600dpi.

F. VECTOR ART

In order to preserve the figures' integrity across multiple computer platforms, we accept files in the following formats: .EPS/.PDF/.PS. All fonts must be embedded or text converted to outlines in order to achieve the best-quality results.

G. COLOR SPACE

The term color space refers to the entire sum of colors that can be represented within the said medium. For our purposes, the three main color spaces are Grayscale, RGB (red/green/blue) and CMYK (cyan/magenta/yellow/black). RGB is generally used with on-screen graphics, whereas CMYK is used for printing purposes.

All color figures should be generated in RGB or CMYK color space. Grayscale images should be submitted in Grayscale color space. Line art may be provided in grayscale OR bitmap colorspace. Note that "bitmap colorspace" and "bitmap file format" are not the same thing. When bitmap color space is selected, .TIF/.TIFF/.PNG are the recommended file formats.

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When preparing your graphics IEEE suggests that you use of one of the following Open Type fonts: Times New Roman, Helvetica, Arial, Cambria, and Symbol. If you are supplying EPS, PS, or PDF files all fonts must be embedded. Some fonts may only be native to your operating system; without the fonts embedded, parts of the graphic may be distorted or missing.

A safe option when finalizing your figures is to strip out the fonts before you save the files, creating "outline" type. This converts fonts to artwork what will appear uniformly on any screen.

I. USING LABELS WITHIN FIGURES

1) Figure Axis Labels

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity "Magnetization," or "Magnetization M," not just "M." Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write "Magnetization (A/m)" or "Magnetization (A$\cdot$m^{-1})," not just "A/m." Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)," not "Temperature/K."

Multipliers can be especially confusing. Write "Magnetization (kA/m)" or "Magnetization (10^3 A/m)." Do not write "Magnetization (A/m) ×1000" because the reader would not know whether the top axis label in Fig. 1 meant 16000 A/m or 0.016 A/m. Figure labels should be legible, approximately 8 to 10 point type.

2) Subfigure Labels in Multipart Figures and Tables

Multipart figures should be combined and labeled before final submission. Labels should appear centered below each subfigure in 8 point Times New Roman font in the format of (a) (b) (c).

J. FILE NAMING

Figures (line artwork or photographs) should be named starting with the first 5 letters of the author's last name. The next characters in the filename should be the number that represents the sequential location of this image in your article. For example, in author "Anderson's" paper, the first three figures would be named ander1.tif, ander2.tif, and ander3.ps.

Tables should contain only the body of the table (not the caption) and should be named similarly to figures, except that '.t' is inserted in-between the author's name and the table number. For example, author Anderson's first three tables would be named ander.t1.tif, ander.t2.ps, ander.t3.eps.

Author photographs should be named using the first five characters of the pictured author's last name. For example, four author photographs for a paper may be named: oppen.ps, moshc.tif, chen.eps, and duran.pdf.

If two authors or more have the same last name, their first initial(s) can be substituted for the fifth, fourth, third... letters of their surname until the degree where there is differentiation. For example, two authors Michael and Monica Oppenheimer's photos would be named oppmi.tif, and oppmo.eps.

K. REFERENCING A FIGURE OR TABLE WITHIN YOUR PAPER

When referencing your figures and tables within your paper, use the abbreviation "Fig." even at the beginning of a sentence. Do not abbreviate "Table." Tables should be numbered with Roman Numerals.

L. CHECKING YOUR FIGURES: THE IEEE GRAPHICS ANALYZER

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Because IEEE will do the final formatting of your paper, you do not need to position figures and tables at the top and bottom of each column. In fact, all figures, figure captions, and tables can be placed at the end of your paper. In addition to, or even in lieu of submitting figures within your final manuscript, figures should be submitted individually, separate from the manuscript in one of the file formats listed above in section VI-J. Place figure captions below the figures; place table titles above the tables. Please do not include captions as part of the figures, or put them in "text boxes" linked to the figures. Also, do not place borders around the outside of your figures.

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VI. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank . . . ." Instead, write "F. A. Author thanks . . . ." In most cases, sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page, not here.

REFERENCES AND FOOTNOTES

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References need not be cited in text. When they are, they appear on the line, in square brackets, inside the punctuation. Multiple references are each numbered with separate brackets. When citing a section in a book, please give the relevant page numbers. In text, refer simply to the reference number. Do not use "Ref." or "reference" except at the beginning of a sentence: "Reference [3] shows . . . ." Please do not use automatic endnotes in *Word*, rather, type the reference list at the end of the paper using the "References" style.

Reference numbers are set flush left and form a column of their own, hanging out beyond the body of the reference. The reference numbers are on the line, enclosed in square brackets. In all references, the given name of the author or editor is abbreviated to the initial only and precedes the last name. Use them all; use *et al*. only if names are not given. Use commas around Jr., Sr., and III in names. Abbreviate conference titles. When citing IEEE transactions, provide the issue number, page range, volume number, year, and/or month if available. When referencing a patent, provide the day and the month of issue, or application. References may not include all information; please obtain and include relevant information. Do not combine references. There must be only one reference with each number. If there is a URL included with the print reference, it can be included at the end of the reference.

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B. FOOTNOTES

Number footnotes separately in superscripts (Insert|Footnote).[1] Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

VII. SUBMITTING YOUR PAPER FOR REVIEW

A. FINAL Stage

When you submit your final version (after your paper has been accepted), print it in two-column format, including figures and tables. You must also send your final manuscript on a disk, via e-mail, or through a Web manuscript submission system as directed by the society contact. You may use *Zip* for large files, or compress files using *Compress, Pkzip, Stuffit,* or *Gzip.*

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Authors should consider the following points:

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2) The length of a submitted paper should be commensurate with the importance, or appropriate to the complexity, of the work. For example, an obvious extension of previously published work might not be appropriate for publication or might be adequately treated in just a few pages.
3) Authors must convince both peer reviewers and the editors of the scientific and technical merit of a paper; the standards of proof are higher when extraordinary or unexpected results are reported.
4) Because replication is required for scientific progress, papers submitted for publication must provide sufficient information to allow readers to perform similar experiments or calculations and use the reported results. Although not everything need be disclosed, a paper must contain new, useable, and fully described information. For example, a specimen's chemical composition need not be reported if the main purpose of a paper is to introduce a new measurement technique. Authors should expect to be challenged by reviewers if the results are not supported by adequate data and critical details.
5) Papers that describe ongoing work or announce the latest technical achievement, which are suitable for presentation at a professional conference, may not be appropriate for publication.

REFERENCES

[1] A. W. Hood and E. R. Priest, "Kink instability of solar coronal loops as the cause of solar flares," *Solar Physics*, vol. 64, no. 2, pp. 303–321, Dec. 1979.

[2] K. Kusano, T. Maeshiro, T. Yokoyama, and T. Sakurai, "The trigger mechanism of solar flares in a coronal arcade with reversed magnetic shear," *The Astrophysical Journal*, vol. 610, pp. 537 – 549, 2004.

[3] K. Kusano, Y. Bamba, T. T. Yamamoto, Y. Iida, S. Toriumi, and A. Asai, "MAGNETIC FIELD STRUCTURES TRIGGERING SOLAR FLARES AND CORONAL MASS EJECTIONS," *The Astrophysical Journal*, vol. 760, no. 1, p. 31, oct 2012.

[4] K. Shibata and T. Magara, "Solar flares: Magnetohydrodynamic processes," *Living Reviews in Solar Physics*, vol. 8, pp. 1–99, 2011.

[5] A. H. McAllister, M. Dryer, P. S. Mclntosh, H. J. Singer, and L. A. Weiss, "A large polar crown coronal mass ejection and a "problem" goemagnetic storm: April 14–23, 1994," *Journal of Geophysical Research: Space Physics*, vol. 101, pp. 13 497 – 13 515, 1996.

[6] T. G. Forbes, "A review on the genesis of coronal mass ejections," *Journal of Geophysical Research: Space Physics*, vol. 105, no. A10, pp. 23 153–23 166, 2000.

[7] D. F. Webb, E. W. Cliver, N. U. Crooker, O. C. S. Cyr, and B. J. Thompson, “Relationship of halo coronal mass ejections, magnetic clouds, and magnetic storms,” *Journal of Geophysical Research*, vol. 105, pp. 7491–7508, 2000.

[8] D. H. Hathaway and R. M. Wilson, “Geomagnetic activity indicates large amplitude for sunspot cycle 24,” *Geophysical Research Letters*, vol. 33, 2006.

[9] J. P. Eastwood, E. Biffis, M. A. Hapgood, L. Green, M. M. Bisi, R. D. Bentley, R. Wicks, L.-A. McKinnell, M. Gibbs, and C. Burnett, “The economic impact of space weather: Where do we stand?” *Risk Analysis*, vol. 37, no. 2, pp. 206–218, 2017.

[10] D. Baker, R. Balstad, M. Bodeau, E. Cameron, J. Fennell, K. Forbes, P. Kintner, L. Leffler, W. Lewis, J. Reagan, T. Stansell, and L. Strachan, *Severe Space Weather Events: Understanding Societal and Economic Impacts: A Workshop Report*. Washington, DC: The National Academies Press, 2008. [Online]. Available: https://nap.nationalacademies.org/catalog/12507/severe-space-weather-events-understanding-societal-and-economic-impacts-a

[11] T. E. Berger, M. J. Holzinger, E. K. Sutton, and J. P. Thayer, “Flying through uncertainty,” *Space Weather*, vol. 18, no. 1, p. e2019SW002373, 2020, e2019SW002373 2019SW002373.

[12] A. Osella, A. Favetto, and E. López, “Currents induced by geomagnetic storms on buried pipelines as a cause of corrosion,” *Journal of Applied Geophysics*, vol. 38, no. 3, pp. 219–233, 1998.

[13] FEMA Homeland Security, “Federal Operating Concept for Impending Space Weather Events,” May 2019. [Online]. Available: https://www.fema.gov/sites/default/files/2020-07/fema$_{i}ncident - annex_{s}pace - weather.pdf$

[14] K. Shiokawa, *Introduction of Space Weather Research on Magnetosphere and Ionosphere of the Earth*. Singapore: Springer Nature Singapore, 2023, pp. 95–113.

[15] Boteler, R. Pirjola, and H. Nevanlinna, “The effects of geomagnetic disturbances on electrical systems at the earth’s surface,” *Advances in Space Research*, vol. 22, no. 1, pp. 17–27, 1998, solar-Terrestrial Relations: Predicting the Effects on the Near-Earth Environment.

[16] A. Pulkkinen, E. Bernabeu, A. Thomson, A. Viljanen, R. Pirjola, D. Boteler, J. Eichner, P. J. Cilliers, D. Welling, N. P. Savani, R. S. Weigel, J. J. Love, C. Balch, C. M. Ngwira, G. Crowley, A. Schultz, R. Kataoka, B. Anderson, D. Fugate, J. J. Simpson, and M. MacAlester, “Geomagnetically induced currents: Science, engineering, and applications readiness,” *Space Weather*, vol. 15, no. 7, pp. 828–856, 2017.

[17] D. H. Boteler, “A 21st century view of the march 1989 magnetic storm,” *Space Weather*, vol. 17, no. 10, pp. 1427–1441, 2019.

[18] N. Srivastava and P. Venkatakrishnan, “Relationship between cme speed and geomagnetic storm intensity,” *Geophysical Research Letters*, vol. 29, no. 9, pp. 1–1–1–4, 2002.

[19] C. M. Ngwira, A. Pulkkinen, E. Bernabeu, J. F. Eichner, A. Viljanen, and G. Crowley, “Characteristics of extreme geoelectric fields and their possible causes: Localized peak enhancements,” *Geophysical Research Letters*, vol. 42, pp. 6916 – 6921, 2015.

[20] V. B. Belakhovsky, V. A. Pilipenko, Y. A. Sakharov, and V. Selivanov, “Characteristics of the variability of a geomagnetic field for studying the impact of the magnetic storms and substorms on electrical energy systems,” *Izvestiya, Physics of the Solid Earth*, vol. 54, pp. 52–65, 2018.

[21] V. B. Belakhovsky, V. A. Pilipenko, M. J. Engebretson, Y. Sakharov, and V. Selivanov, “Impulsive disturbances of the geomagnetic field as a cause of induced currents of electric power lines,” *Journal of Space Weather and Space Climate*, 2019.

[22] A. P. Dimmock, L. Rosenqvist, J.-O. Hall, A. Viljanen, E. Yordanova, I. Honkonen, M. André, and E. C. Sjöberg, “The gic and geomagnetic response over fennoscandia to the 7–8 september 2017 geomagnetic storm,” *Space Weather*, vol. 17, pp. 1010 – 989, 2019.

[23] G. Tóth, D. L. De Zeeuw, T. I. Gombosi, W. B. Manchester, A. J. Ridley, I. V. Sokolov, and I. I. Roussev, “Sun-to-thermosphere simulation of the 28–30 october 2003 storm with the space weather modeling framework,” *Space Weather*, vol. 5, no. 6, 2007.

[24] M. J. Engebretson, V. A. Pilipenko, E. S. Steinmetz, M. B. Moldwin, M. G. Connors, D. H. Boteler, H. J. Singer, H. J. Opgenoorth, A. Schillings, S. Ohtani, J. W. Gjerloev, and C. T. Russell, “Nighttime magnetic perturbation events observed in arctic canada: 3. occurrence and amplitude as functions of magnetic latitude, local time, and magnetic disturbance indices,” *Space Weather*, vol. 19, 2020.

[25] P. B. Kotzé, P. J. Cilliers, and P. R. Sutcliffe, “The role of sansa’s geomagnetic observation network in space weather monitoring: A review,” *Space Weather*, vol. 13, no. 10, pp. 656–664, 2015.

[26] U. Villante and M. Regi, “Solar flare effect preceding halloween storm (28 october 2003): Results of a worldwide analysis,” *Journal of Geophysical Research: Space Physics*, vol. 113, no. A3, 2008.

[27] C. S. Barbosa, L. R. Alves, R. Caraballo, G. A. Hartmann, A. R. R. Papa, and R. J. Pirjola, “Analysis of geomagnetically induced currents at a low-latitude region over the solar cycles 23 and 24: comparison between measurements and calculations,” *Journal of Space Weather and Space Climate*, vol. 5, 2015.

[28] I. S. Batista, M. A. Abdu, J. R. de Souza, F. C. P. Bertoni, M. T. Matsuoka, P. de Oliveira Camargo, and G. J. Bailey, “Unusual early morning development of the equatorial anomaly in the brazilian sector during the halloween magnetic storm,” *Journal of Geophysical Research*, vol. 111, p. 10, 2006.

[29] C. Schultz, “Solar storms can destabilize power grids at midlatitudes,” *Eos, Transactions American Geophysical Union*, vol. 93, no. 41, pp. 412–412, 2012.

[30] J. J. Love, G. M. Lucas, A. Kelbert, and P. A. Bedrosian, “Geoelectric hazard maps for the mid-atlantic united states: 100 year extreme values and the 1989 magnetic storm,” *Geophysical Research Letters*, vol. 45, no. 1, pp. 5–14, 2018.

[31] R. A. Marshall, M. Dalzell, C. L. Waters, P. Goldthorpe, and E. A. Smith, “Geomagnetically induced currents in the new zealand power network,” *Space Weather*, vol. 10, no. 8, 2012.

[32] J. M. Torta, S. Marsal, and M. Quintana, “Assessing the hazard from geomagnetically induced currents to the entire high-voltage power network in spain,” *Earth, Planets and Space*, vol. 66, pp. 1–17, 2014.

[33] L. Orr, S. C. Chapman, and C. D. Beggan, “Wavelet and network analysis of magnetic field variation and geomagnetically induced currents during large storms,” *Space Weather*, vol. 19, no. 9, p. e2021SW002772, 2021, e2021SW002772 2021SW002772.

[34] F. Simpson and K. Bahr, “Estimating the electric field response to the halloween 2003 and september 2017 magnetic storms across scotland using observed geomagnetic fields, magnetotelluric impedances and perturbation tensors,” *Journal of Space Weather and Space Climate*, vol. 10, no. 1, pp. 48–, 2020.

[35] Y. Ebihara, S. ichi Watari, and S. Kumar, “Prediction of geomagnetically induced currents (GICs) flowing in japanese power grid for carrington-class magnetic storms,” *Earth, Planets and Space*, vol. 73, pp. 1–10, 2021.

[36] D. J. Knipp, “Synthesis of geomagnetically induced currents: Commentary and research,” *Space Weather*, vol. 13, no. 11, pp. 727–729, 2015.

[37] J. Gannon, *Geomagnetically induced currents from the sun to the power grid*, ser. Geophysical Monograph Series, J. L. Gannon, A. Swidinsky, and Z. Xu, Eds. Nashville, TN: John Wiley & Sons, Dec. 2019.

[38] “National Space Weather Strategy and Action Plan,” Mar. 2019. [Online]. Available: https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/03/National-Space-Weather-Strategy-and-Action-Plan-2019.pdf

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