

Две ранее неизвестные супервспышки на Солнце, случившиеся в 7176 и 5259 годах до н.э. [https://www.gazeta.ru/science/news/2021/09/13/n\\_16526132.shtml](https://www.gazeta.ru/science/news/2021/09/13/n_16526132.shtml)

### Extreme Solar Events: Setting up a Paradigm

Review

Usoskin, I., Miyake, F., Baroni, M. et al.

Space Sci Rev 219, 73 (2023).

<https://doi.org/10.1007/s11214-023-01018-1>

<https://link.springer.com/content/pdf/10.1007/s11214-023-01018-1.pdf> File

### Multiproxy Reconstructions of Integral Energy Spectra for Extreme Solar Particle Events of 7176 BCE, 660 BCE, 775 CE, and 994 CE

Sergey Koldobskiy, Florian Mekhaldi, Gennady Kovaltsov, Ilya Usoskin

JGR Volume128, Issue3 March 2023 e2022JA031186

<https://doi.org/10.1029/2022JA031186>

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2022JA031186>

### Tree rings reveal two strong solar proton events in 7176 and 5259 BCE

Nicolas Brehm, Marcus Christl, Florian Adolphi, Raimund Muscheler, ....Ilya Usoskin, Lukas Wacker  
Research Square 2021

[https://assets.researchsquare.com/files/rs-753272/v1\\_covered.pdf](https://assets.researchsquare.com/files/rs-753272/v1_covered.pdf)

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DOI: [10.21203/rs.3.rs-753272/v1](https://doi.org/10.21203/rs.3.rs-753272/v1)

774 AD

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### Extreme solar particle event of 774 AD: reference as the worst-case scenario for space weather

Alexander Mishev, a,b,\* Ilya Usoskina, b and Sanja Panovska

ICRC2023 2023

<https://pos.sissa.it/444/1229/pdf>

### Revisiting Empirical Solar Energetic Particle Scaling Relations I. Solar flares

Athanasios Papaioannou, Konstantin Herbst, Tobias Ramm, Edward W. Cliver, David Lario, Astrid M. Veronig

A&A 2022

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### Extreme solar events

Review

Edward W. Cliver, Carolus J. Schrijver, Kazunari Shibata & Ilya G. Usoskin

Living Reviews in Solar Physics volume 19, Article number: 2 (2022)

<https://link.springer.com/content/pdf/10.1007/s41116-022-00033-8.pdf>

### On the Size of the Flare Associated with the Solar Proton Event in 774 AD

E. W. Cliver<sup>1,2</sup>, H. Hayakawa<sup>3,4,5,6</sup>, Jeffrey J. Love<sup>7</sup>, and D. F. Neidig<sup>8,9</sup>

2020 ApJ 903 41

<https://doi.org/10.3847/1538-4357/abad93>

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### **Study of the Impact of past extreme Solar Events on the modern air traffic**

[G. Hubert](#), [S. Aubry](#)

Space Weather e2020SW002665 2021

<https://doi.org/10.1029/2020SW002665>

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### **The Celestial Sign in the Anglo-Saxon Chronicle in the 770s: Insights on Contemporary Solar Activity**

Hisashi **Hayakawa**, F. Richard Stephenson, Yuta Uchikawa, Yusuke Ebihara, Christopher J. Scott, Matthew N. Wild, Julia Wilkinson, David M. Willis

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January 12/13 776

### **Do the Chinese Astronomical Records Dated AD 776 January 12/13 Describe an Auroral Display or a Lunar Halo? A Critical Re-examination**

F. Richard **Stephenson**, David M. Willis, Hisashi Hayakawa, Yusuke Ebihara, Christopher J. Scott, Julia Wilkinson, Matthew N. Wild

[Solar Physics](#) April 2019, 294:36

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**1052 and 1279**

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**6-8 March 1582**

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Kentaro Hattori, Hisashi Hayakawa, Yusuke Ebihara

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**Candidate Auroral Observations during the Major Solar-Terrestrial Storm in May 1680: Implication for Space Weather Events during the Maunder Minimum**

Hisashi Hayakawa, Kristian Schlegel, Bruno P. Besser, Yusuke Ebihara

2021 ApJ 909 29

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<https://arxiv.org/ftp/arxiv/papers/2008/2008.13739.pdf>

**1727–1748**

**An Overview of Sunspot Observations in 1727–1748**

Hisashi Hayakawa<sup>1,2,3,4</sup>, Kentaro Hattori<sup>5</sup>, Mitsuru Sôma<sup>6</sup>, Tomoya Iju<sup>6</sup>, Bruno P. Besser<sup>7,8</sup>, and Shunsuke Kosaka<sup>1,9,10</sup>

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**February 1730**

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### **A Great Space Weather Event in February 1730**

Hisashi [Hayakawa](#), [Yusuke Ebihara](#), [José M. Vaquero](#), [Kentaro Hattori](#), [V́ctor M. S. Carrasco](#), [María de la Cruz Gallego](#), [Satoshi Hayakawa](#), [Yoshikazu Watanabe](#), [Kiyomi Iwahashi](#), [Harufumi Tamazawa](#), [Akito D. Kawamura](#), [Hiroaki Isobe](#)

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#### **Extreme solar events**

**Review**

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[Living Reviews in Solar Physics](#) volume 19, Article number: 2 (2022)

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#### **Timelines as a tool for learning about space weather storms**

Delores J. [Knipp](#)<sup>1,2\*</sup>, Valerie Bernstein<sup>1</sup>, Kaiya Wahl<sup>3</sup> and Hisashi Hayakawa<sup>4,5,6</sup>

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#### **Possible Cause of Extremely Bright Aurora Witnessed in East Asia on 17 September 1770**

Yusuke [Ebihara](#), Hisashi Hayakawa, Kiyomi Iwahashi, Harufumi Tamazawa, Akito Davis Kawamura, Hiroaki Isobe

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#### **Inclined Zenith Aurora over Kyoto on 17 September 1770: Graphical Evidence of Extreme Magnetic Storm**

Ryuhō [Kataoka](#), Kiyomi Iwahashi

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#### **Long-Lasting Extreme Magnetic Storm Activities in 1770 Found in Historical Documents**

Hisashi [Hayakawa](#), [Kiyomi Iwahashi](#), [Yusuke Ebihara](#), [Harufumi Tamazawa](#), [Kazunari Shibata](#), [Delores J. Knipp](#), [Akito Davis Kawamura](#), [Kentaro Hattori](#), [Kumiko Mase](#), [Ichiro Nakanishi](#), [Hiroaki Isobe](#)

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### **26 Aug 1793**

#### **Iwahashi Zenbei's Sunspot Drawings in 1793 in Japan**

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#### **Sporadic Aurora near Geomagnetic Equator: In the Philippines, on 27 October 1856**

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**28-29 Aug 1859**

## Temporal and Spatial Evolutions of a Large Sunspot Group and Great Auroral Storms around the Carrington Event in 1859

Hisashi [Hayakawa](#), [Yusuke Ebihara](#), [David M. Willis](#), [Shin Toriumi](#), [Tomoya Iju](#), [Kentaro Hattori](#), [Matthew N. Wild](#), [Denny M. Oliveira](#), [Ilaria Ermolli](#), [José R. Ribeiro](#), [Ana P. Correia](#), [Ana I. Ribeiro](#), [Delores J. Knipp](#)

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**1 Sept 1859**

## HOW BIG WAS CARRINGTON'S SUNSPOT?

<https://www.spaceweather.com> June 7 2023

### On the uncertain intensity estimate of the 1859 Carrington storm

Jeffrey J. [Love](#)<sup>1\*</sup>, E. Joshua Rigler<sup>1</sup>, Hisashi Hayakawa<sup>2,3,4</sup> and Kalevi Mursula<sup>5</sup>  
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## Digitized Continuous Magnetic Recordings for the August/September 1859 Storms From London, UK

C. D. Beggan, E. Clarke, E. Lawrence, E. Eaton, J. Williamson, K. Matsumoto, H. Hayakawa  
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### The relevance of local magnetic records when using extreme space weather events as benchmarks

Elena [Saiz](#)<sup>\*</sup>, Consuelo Cid and Antonio Guerrero

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### Low-Latitude Aurorae during the Extreme Space Weather Events in 1859

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### Extreme Space Weather Events: From Cradle to Grave

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**Review**

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Lisa M. **Winter**, Jennifer Gannon, Rick Pernak, Stuart Huston, Richard Quinn, Edward Pope, Alexis Ruffenach, Pietro Bernardara, Nicholas Crocker

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### **East Asian Observations of Low Latitude Aurora during the Carrington Magnetic Storm**

Hisashi **Hayakawa**, Kiyomi Iwahashi, Harufumi Tamazawa, [Hiroaki Iso](#), [Ryuho Kataoka](#), [Yusuke Ebihara](#), [Hiroko Miyahara](#), [Akito Davis Kawamura](#), [Kazunari Shibata](#)

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### **Searching for Carrington-like events and their signatures and triggers**

Elena **Saiz**\*, Antonio Guerrero, Consuelo Cid, Judith Palacios and Yolanda Cerrato

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### **Modeling extreme ‘Carrington-type’ space weather events using three-dimensional global MHD simulations†**

Chigomezyo M. **Ngwira**<sup>1,2,\*</sup>, Antti Pulkkinen<sup>2</sup>, Maria M. Kuznetsova<sup>2</sup> and Alex Glocer

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**Freed**, A. J.; Russell, C. T.

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### **CME front and severe space weather**

N. **Balan**<sup>1,2,6,\*</sup>, R. Skoug<sup>3</sup>, S. Tulasi Ram<sup>4</sup>, P. K. Rajesh<sup>2</sup>, K. Shiokawa<sup>1</sup>, Y. Otsuka<sup>1</sup>, I. S. Batista<sup>5</sup>, Y. Ebihara<sup>6</sup> and T. Nakamura<sup>7</sup>

JGR, 2014

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Piers **Jiggins**\*, Marc-Andre Chavy-Macdonald, Giovanni Santin, Alessandra Menicucci, Hugh Evans and Alain Hilgers

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<http://www.swsc-journal.org/articles/swsc/pdf/2014/01/swsc130038.pdf>

### **The 1859 space weather event revisited: limits of extreme activity**

Edward W. **Cliver**<sup>1\*</sup> and William F. Dietrich<sup>2</sup>

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**13 May 1869** Геомагнитная буря aa~177.6

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## The relevance of local magnetic records when using extreme space weather events as benchmarks

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**24-25 Oct 1870** Геомагнитная буря aa~185.2

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**12 Feb 1871** Геомагнитная буря aa~157.3

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**9 Apr 1871** Геомагнитная буря aa~120.7

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**4 February 1872**

## The Extreme Space Weather Event of 1872 February: Sunspots, Magnetic Disturbance, and Auroral Displays

Hisashi **Hayakawa**<sup>1,2</sup>, Edward W. Cliver<sup>3</sup>, Frédéric Clette<sup>4</sup>, Yusuke Ebihara<sup>5,6</sup> +++  
**2023** ApJ 959 23

<https://iopscience.iop.org/article/10.3847/1538-4357/acc6cc/pdf>

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[Living Reviews in Solar Physics](#) volume 19, Article number: 2 (**2022**)

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## The Great Aurora of 4 February 1872 observed by Angelo Secchi in Rome

Francesco **Berrilli**, [Luca Giovannelli](#)

Journal of Space Weather and Space Climate **12**, 3 **2022**

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Space Weather 2019

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## The Great Space Weather Event during February 1872 Recorded in East Asia

Hisashi [Hayakawa](#), [Yusuke Ebihara](#), [David M. Willis](#), [Kentaro Hattori](#), [Alessandra S. Giunta](#), [Matthew N. Wild](#), [Satoshi Hayakawa](#), [Shin Toriumi](#), [Yasuyuki Mitsuma](#), [Lee T. Macdonald](#), [Kazunari Shibata](#), [Sam M. Silverman](#)

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**14 Oct 1871** Геомагнитная буря aa~219.6

[Lefèvre](#), L., [Vennerstrøm](#), S., [Dumbović](#), M., [Vršnak](#), B., [Sudar](#), D., [Arlt](#), R., [Clette](#), F., [Crosby](#), N. (2016). **Detailed Analysis of Solar Data Related to Historical Extreme Geomagnetic Storms: 1868 – 2010**. Solar Phys. Volume 291, Issue 5, pp 1483-1531 2016

**18 Oct 1872**

Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets

G. [Bernoux](#), [V. Maget](#)

Space Weather **Volume 18, Issue 6** e2020SW002450 2020

<https://sci-hub.tw/10.1029/2020SW002450>

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002450>

**13 Nov 1872**

Valderrama in the 21st Century,

Hugh [Hudson](#)

RHESSI Nugget No. 310, Oct 2017

[http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama\\_in\\_the\\_21st\\_Century](http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama_in_the_21st_Century)

**16-18 November 1882** Геомагнитная буря Dst~ -386

Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets

G. [Bernoux](#), [V. Maget](#)

Space Weather **Volume 18, Issue 6** e2020SW002450 2020

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## The Electric Storm of November 1882

Jeffrey J. [Love](#)

Space Weather 12 January 2018 Vol: 16, Pages: 37–46

<http://sci-hub.se/10.1002/2017SW001795>

**10 September 1886**

Valderrama in the 21st Century,

Hugh [Hudson](#)

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### **Evidence for a White-light Flare on 10 September 1886**

J.M. **Vaquero**, M. Vázquez, J. Sánchez Almeida

Solar Phys. 2017

<https://arxiv.org/pdf/1701.05910v1.pdf>

### **17 June 1891**

#### **Valderrama in the 21st Century,**

Hugh **Hudson**

RHESSI Nugget No. 310, Oct 2017

[http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama in the 21st Century](http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama_in_the_21st_Century)

### **15 July 1892**

#### **Valderrama in the 21st Century,**

Hugh **Hudson**

RHESSI Nugget No. 310, Oct 2017

[http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama in the 21st Century](http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/Valderrama_in_the_21st_Century)

### **30 Oct- 1 Nov 1903**

Source 30 Nov, 06 UT, Dst ~-513 nT, 31 Nov, 14 UT

See <https://www.spaceweather.com> 31 July 2020

### **The relevance of local magnetic records when using extreme space weather events as benchmarks**

Elena **Saiz\***, Consuelo Cid and Antonio Guerrero

J. Space Weather Space Clim. 2021, 11, 35

<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>

<https://doi.org/10.1051/swsc/2021018>

### **The Extreme Space Weather Event in 1903 October/November: An Outburst from the Quiet Sun**

Hisashi **Hayakawa**, [Paulo Ribeiro](#), [José M. Vaquero](#), [María Cruz Gallego](#), [Delores J. Knipp](#), [Florian Mekhaldi](#), [Ankush Bhaskar](#), [Denny M. Oliveira](#), [Yuta Notsu](#), [Víctor M. S. Carrasco](#), [Ana Caccavari](#), [Bhaskara Veenadhari](#), [Shyamoli Mukherjee](#), [Yusuke Ebihara](#)

ApJL 897 L10 2020

<https://arxiv.org/ftp/arxiv/papers/2001/2001.04575.pdf>

[sci-hub.tw/10.3847/2041-8213/ab6a18](https://sci-hub.tw/10.3847/2041-8213/ab6a18)

### **12 May 1909**

Hale GE (1931) **The spectrohelioscope and its work. Part III. Solar eruptions and their apparent terrestrial effects.** ApJ 73:379–412

### **History and development of coronal mass ejections as a key player in solar terrestrial relationship**

N. **Gopalswamy**

[Geoscience Letters](#) volume 3, Article number: 8 (2016)

<https://geoscienceletters.springeropen.com/track/pdf/10.1186/s40562-016-0039-2>

DOI 10.1186/s40562-016-0039-2

### **25 Sept 1909**

### **The relevance of local magnetic records when using extreme space weather events as benchmarks**

Elena **Saiz\***, Consuelo Cid and Antonio Guerrero

J. Space Weather Space Clim. **2021**, 11, 35  
<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>  
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### **Estimating satellite orbital drag during historical magnetic superstorms**

Denny M. [Oliveira](#) , [Eftyhia Zesta](#) , [Hisashi Hayakawa](#) , [Ankush Bhaskar](#)  
Space Weather **2020**  
<https://doi.org/10.1029/2020SW002472>  
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002472>

### **Temporal and Spatial Evolutions of a Large Sunspot Group and Great Auroral Storms around the Carrington Event in 1859**

Hisashi [Hayakawa](#), [Yusuke Ebihara](#), [David M. Willis](#), [Shin Toriumi](#), [Tomoya Iju](#), [Kentaro Hattori](#), [Matthew N. Wild](#), [Denny M. Oliveira](#), [Iaria Ermolli](#), [José R. Ribeiro](#), [Ana P. Correia](#), [Ana I. Ribeiro](#), [Delores J. Knipp](#)  
Space Weather **2019**  
<https://arxiv.org/ftp/arxiv/papers/1908/1908.10326.pdf>

### **The extreme space weather event in September 1909**

Hisashi [Hayakawa](#) [Yusuke Ebihara](#) [Edward W Cliver](#) [Kentaro Hattori](#) [Shin Toriumi](#) [Jeffrey J Love](#) [Norio Umemura](#) [Kosuke Namekata](#) [Takahito Sakaue](#) [Takuya Takahashi...](#) [Show more](#)  
MNRAS, Volume 484, Issue 3, 11 April **2019**, Pages 4083–4099,  
<https://doi.org/10.1093/mnras/sty3196>  
[sci-hub.se/10.1093/mnras/sty3196](https://sci-hub.se/10.1093/mnras/sty3196)

### **On the Intensity of the Magnetic Superstorm of September 1909**

Jeffrey J. [Love](#) [Hisashi Hayakawa](#) [Edward W. Cliver](#)  
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### **10-11 Feb 1917**

#### **Sunspot Observations on 10 and 11 February 1917: A Case Study in Collating Known and Previously Undocumented Records**

D. M. [Willis](#) [J. Wilkinson](#) [C. J. Scott](#) [M. N. Wild](#) [F. R. Stephenson](#) [H. Hayakawa](#) [R. Brugge](#) [L. T. Macdonald](#)  
Space weather  
[Volume16, Issue11](#) November **2018** Pages 1740-1752  
[sci-hub.tw/10.1029/2018SW002012](https://sci-hub.tw/10.1029/2018SW002012)

### **1918 Mar 07**

#### **The relevance of local magnetic records when using extreme space weather events as benchmarks**

Elena [Saiz\\*](#), Consuelo Cid and Antonio Guerrero  
J. Space Weather Space Clim. **2021**, 11, 35  
<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>  
<https://doi.org/10.1051/swsc/2021018>

### **14–15 May 1921**

See <https://www.spaceweather.com> for 13 May 2020 and 15 May 2021

### **Extreme solar events**

[Edward W. Cliver](#), [Carolus J. Schrijver](#), [Kazunari Shibata](#) & [Ilya G. Usoskin](#)  
[Living Reviews in Solar Physics](#) volume 19, Article number: 2 (**2022**)  
<https://link.springer.com/content/pdf/10.1007/s41116-022-00033-8.pdf>

### **Review**

## **The relevance of local magnetic records when using extreme space weather events as benchmarks**

Elena **Saiz\***, Consuelo Cid and Antonio Guerrero

J. Space Weather Space Clim. **2021**, 11, 35

<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>

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## **Estimating satellite orbital drag during historical magnetic superstorms**

Denny M. **Oliveira**, [Eftyhia Zesta](#), [Hisashi Hayakawa](#), [Ankush Bhaskar](#)

Space Weather **2020**

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<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002472>

## **Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets**

G. **Bernoux**, [V. Maget](#)

Space Weather **Volume 18, Issue 6** e2020SW002450 **2020**

<https://sci-hub.tw/10.1029/2020SW002450>

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## **Extreme Geomagnetic Storms – 1868 – 2010**

S. **Vennerstrom**, L. Lefevre, M. Dumbović, N. Crosby, O. Malandraki, I. Patsou, F. Clette, A. Veronig, B. Vršnak, K. Leer, T. Moretto

[Solar Physics](#) May **2016**, Volume 291, [Issue 5](#), pp 1447–1481

<https://link.springer.com/content/pdf/10.1007%2Fs11207-016-0897-y.pdf>

## **The Great Storm of May 1921: an Exemplar of a Dangerous Space Weather Event**

Mike **Hapgood**

Space Weather **2019**

[sci-hub.se/10.1029/2019SW002195](https://sci-hub.se/10.1029/2019SW002195)

## **The extreme solar storm of May 1921: observations and a complex topological model**

H. **Lundstedt**<sup>1</sup>, T. Persson<sup>2</sup>, and V. Andersson

Ann. Geophys., 33, 109-116, **2015**

<https://www.ann-geophys.net/33/109/2015/angeo-33-109-2015.pdf>

## **The 1859 space weather event revisited: limits of extreme activity**

Edward W. **Cliver**<sup>1\*</sup> and William F. Dietrich<sup>2</sup>

J. Space Weather Space Clim., Volume 3, **2013**, A31; [File](#)

**Kappenman**, J. G. (2006). Great geomagnetic storms and extreme impulsive geomagnetic field disturbance events—an analysis of observational evidence including the great storm of May 1921. Advances in Space Research 38(2), 188-199. doi: 10.1016/j.asr.2005.08.055

**17-18 Jan 1938** Dcx~171 nT

## **The intensity and evolution of the extreme storms in January 1938**

Hisashi **Hayakawa**, [Kentaro Hattori](#), [Alexei A. Pevtsov](#), [Yusuke Ebihara](#), [Margaret A. Shea](#), [Ken G. McCracken](#), [Ioannis A. Daglis](#), [Ankush Bhaskar](#), [Paulo Ribeiro](#), [Delores J. Knipp](#)

ApJ **2020**

<https://arxiv.org/ftp/arxiv/papers/2010/2010.15762.pdf>

**21-22 Jan 1938** Dcx ≈ -328 nT

### Timelines as a tool for learning about space weather storms

Delores J. **Knipp**<sup>1,2\*</sup>, Valerie Bernstein<sup>1</sup>, Kaiya Wahl<sup>3</sup> and Hisashi Hayakawa<sup>4,5,6</sup>  
J. Space Weather Space Clim. **2021**, 11, 29

<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200106.pdf>

<https://doi.org/10.1051/swsc/2021011>

### The intensity and evolution of the extreme storms in January 1938

Hisashi **Hayakawa**, [Kentaro Hattori](#), [Alexei A. Pevtsov](#), [Yusuke Ebihara](#), [Margaret A. Shea](#), [Ken G. McCracken](#), [Ioannis A. Daglis](#), [Ankush Bhaskar](#), [Paulo Ribeiro](#), [Delores J. Knipp](#)

ApJ **2020**

<https://arxiv.org/ftp/arxiv/papers/2010/2010.15762.pdf>

### Extreme Geomagnetic Storms – 1868 – 2010

S. **Vennerstrom**, L. Lefevre, M. Dumbović, N. Crosby, O. Malandraki, I. Patsou, F. Clette, A. Veronig, B. Vršnak, K. Leer, T. Moretto

[Solar Physics](#) May **2016**, Volume 291, [Issue 5](#), pp 1447–1481

<https://link.springer.com/content/pdf/10.1007%2Fs11207-016-0897-y.pdf>

**25-26 Jan 1938**  $D_{cx} \approx -336$  nT

### Extreme Solar Events: Setting up a Paradigm

**Review**

**Usoskin**, I., Miyake, F., Baroni, M. et al.

Space Sci Rev 219, 73 (**2023**).

<https://doi.org/10.1007/s11214-023-01018-1>

<https://link.springer.com/content/pdf/10.1007/s11214-023-01018-1.pdf> File

### Timelines as a tool for learning about space weather storms

Delores J. **Knipp**<sup>1,2\*</sup>, Valerie Bernstein<sup>1</sup>, Kaiya Wahl<sup>3</sup> and Hisashi Hayakawa<sup>4,5,6</sup>  
J. Space Weather Space Clim. **2021**, 11, 29

<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200106.pdf>

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### The intensity and evolution of the extreme storms in January 1938

Hisashi **Hayakawa**, [Kentaro Hattori](#), [Alexei A. Pevtsov](#), [Yusuke Ebihara](#), [Margaret A. Shea](#), [Ken G. McCracken](#), [Ioannis A. Daglis](#), [Ankush Bhaskar](#), [Paulo Ribeiro](#), [Delores J. Knipp](#)

ApJ **2020**

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### Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets

G. **Bernoux**, [V. Maget](#)

Space Weather **Volume 18, Issue 6** e2020SW002450 **2020**

<https://sci-hub.tw/10.1029/2020SW002450>

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**20-25 Mar 1940**

### The extreme solar and geomagnetic storms on 1940 March 20–25

Hisashi **Hayakawa**, [Denny M Oliveira](#), [Margaret A Shea](#), [Don F Smart](#), [Seán P Blake](#), [Kentaro Hattori](#), [Ankush T Bhaskar](#), [Juan J Curto](#), [Daniel R Franco](#), [Yusuke Ebihara](#)

MNRAS, Volume 517, Issue 2, December **2022**, Pages 1709–1723,

<https://doi.org/10.1093/mnras/stab3615>

<https://academic.oup.com/mnras/article-pdf/517/2/1709/46495872/stab3615.pdf>

**24 Mar 1940**

See <https://www.spaceweather.com> for 9–10 Aug 2023

### **The March 1940 Superstorm: Geoelectromagnetic Hazards and Impacts on American Communication and Power Systems**

[Jeffrey J. Love](#), [E. Joshua Rigler](#), [Michael D. Hartinger](#), [Greg M. Lucas](#), [Anna Kelbert](#), [Paul A. Bedrosian](#)  
Space Weather [Volume 21, Issue 6](#) June 2023 e2022SW003379  
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2022SW003379>

### **The relevance of local magnetic records when using extreme space weather events as benchmarks**

Elena [Saiz\\*](#), Consuelo Cid and Antonio Guerrero  
J. Space Weather Space Clim. 2021, 11, 35  
<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>  
<https://doi.org/10.1051/swsc/2021018>

### **31 March 1940**

#### **Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets**

G. [Bernoux](#), [V. Maget](#)  
Space Weather [Volume 18, Issue 6](#) e2020SW002450 2020  
<https://sci-hub.tw/10.1029/2020SW002450>  
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002450>

**28 Feb-1 March 1941** 18 UT, Geostorm Dst=-382  
[Cliver & Svalgaard \(2004\)](#)

### **Extreme Solar Events: Setting up a Paradigm**

**Review**

[Usoskin](#), I., [Miyake](#), F., [Baroni](#), M. et al.  
Space Sci Rev 219, 73 (2023).  
<https://doi.org/10.1007/s11214-023-01018-1>  
<https://link.springer.com/content/pdf/10.1007/s11214-023-01018-1.pdf> File

### **The Extreme Space Weather Event in 1941 February/March**

[Hisashi Hayakawa](#)<sup>1,2,3,4</sup>, [Sean P. Blake](#)<sup>5,6</sup>, [Ankush Bhaskar](#)<sup>5,6,7</sup>, [Kentaro Hattori](#)<sup>8</sup>, [Denny M. Oliveira](#)<sup>5,9</sup>, and [Yusuke Ebihara](#)<sup>1</sup>  
2021 ApJ 908 209  
<https://doi.org/10.3847/1538-4357/abb772>  
<https://iopscience.iop.org/article/10.3847/1538-4357/abb772/pdf>

### **17-18 Sept 1941**

#### **Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets**

G. [Bernoux](#), [V. Maget](#)  
Space Weather [Volume 18, Issue 6](#) e2020SW002450 2020  
<https://sci-hub.tw/10.1029/2020SW002450>  
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002450>

### **The Geomagnetic Blitz of September 1941**

[Love](#), J. J., and P. Coisson  
(2016), Eos, 97,doi:10.1029/2016EO059319.  
[https://eos.org/features/the-geomagnetic-blitz-of-september-1941?utm\\_source=eos&utm\\_medium=email&utm\\_campaign=EosBuzz091616](https://eos.org/features/the-geomagnetic-blitz-of-september-1941?utm_source=eos&utm_medium=email&utm_campaign=EosBuzz091616)

**28 Feb 1942**

**GLE1**

## Extreme solar events

Review

[Edward W. Cliver](#), [Carolus J. Schrijver](#), [Kazunari Shibata](#) & [Ilya G. Usoskin](#)  
[Living Reviews in Solar Physics](#) volume 19, Article number: 2 (2022)  
<https://link.springer.com/content/pdf/10.1007/s41116-022-00033-8.pdf>

## Re-examination of the First Five Ground-Level Events

[Shea, M. A.](#); [Smart, D.](#)

36th International Cosmic Ray Conference (ICRC2019), held July 24th-August 1st, 2019 in Madison, WI, U.S.A. Online at <https://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=358>, id.1149, 2019  
<https://pos.sissa.it/358/1149/pdf>

7 March 1942

GLE2

## Re-examination of the First Five Ground-Level Events

[Shea, M. A.](#); [Smart, D.](#)

36th International Cosmic Ray Conference (ICRC2019), held July 24th-August 1st, 2019 in Madison, WI, U.S.A. Online at <https://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=358>, id.1149, 2019  
<https://pos.sissa.it/358/1149/pdf>

28 March 1946

## Intensity and time series of extreme solar-terrestrial storm in 1946 March

Hisashi [Hayakawa](#), [Yusuke Ebihara](#), [Alexei A Pevtsov](#), [Ankush Bhaskar](#), [Nina Karachik](#), [Denny M Oliveira](#)

Monthly Notices of the Royal Astronomical Society, Volume 497, Issue 4, 2020, Pages 5507–5517,  
<https://doi.org/10.1093/mnras/staa1508>  
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## Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets

G. [Bernoux](#), [V. Maget](#)

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<https://sci-hub.tw/10.1029/2020SW002450>  
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002450>

25 July 1946

GLE3

## Extreme Solar Events: Setting up a Paradigm

Review

[Usoskin, I.](#), [Miyake, F.](#), [Baroni, M.](#) et al.

Space Sci Rev 219, 73 (2023).

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## Re-examination of the First Five Ground-Level Events

[Shea, M. A.](#); [Smart, D.](#)

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<https://pos.sissa.it/358/1149/pdf>

## Flare-productive active regions

Review

Shin [Toriumi](#), [Haimin Wang](#)

Living Reviews in Solar Physics 2019

<https://arxiv.org/pdf/1904.12027.pdf>

## Extreme solar storms based on solar magnetic field

Brigitte [Schmieder](#)

Varsiti Conference in Varna June 2016      2017

<https://arxiv.org/pdf/1708.01790.pdf>

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## Magnetic Properties of Solar Active Regions that Govern Large Solar Flares and Eruptions

Shin **Toriumi**, Carolus J. Schrijver, Louise K. Harra, Hugh Hudson, Kaori Nagashima

ApJ 2016

<https://arxiv.org/pdf/1611.05047v1.pdf>

**23 Sep 1946**

## Characterizing extreme geomagnetic storms using Extreme Value Analysis: a discussion on the representativeness of short datasets

G. **Bernoux**, [V. Maget](#)

Space Weather **Volume 18, Issue 6** e2020SW002450 2020

<https://sci-hub.tw/10.1029/2020SW002450>

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020SW002450>

**4-5 Apr 1947**

## Extreme solar events

**Review**

[Edward W. Cliver](#), [Carolus J. Schrijver](#), [Kazunari Shibata](#) & [Ilya G. Usoskin](#)

[Living Reviews in Solar Physics](#) volume 19, Article number: 2 (2022)

<https://link.springer.com/content/pdf/10.1007/s41116-022-00033-8.pdf>

## Extreme solar storms based on solar magnetic field

Brigitte **Schmieder**

Varsiti Conference in Varna June 2016      2017

<https://arxiv.org/pdf/1708.01790.pdf>

File

**19 Nov 1949**

**GLE#4**

Spectra and anisotropy during GLE # 4 on 19 November 1949 derived using historical records

PoS(ICRC2023)1234 **pdf** [A. Mishev](#), [H. Hayakawa](#), [I. Usoskin](#), [K. McCracken](#), [M. Shea](#) and [D. Smart](#)

## Re-examination of the First Five Ground-Level Events

[Shea](#), M. A.; [Smart](#), D.

36th International Cosmic Ray Conference (ICRC2019), held July 24th-August 1st, 2019 in Madison, WI, U.S.A. Online at <https://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=358>, id.1149, 2019

<https://pos.sissa.it/358/1149/pdf>

**May 1951**

## Large Sunspot Groups and Great Magnetic Storms: Magnetic Suppression of CMEs

Edward W. **Cliver**<sup>1</sup>, Werner Pötzi<sup>2</sup>, and Astrid M. Veronig<sup>2,3</sup>

2022 ApJ 938 136

<https://iopscience.iop.org/article/10.3847/1538-4357/ac847d/pdf>

**14 Feb 1956**

## Relationship of peak fluxes of solar radio bursts and X-ray class of solar flares: Application to early great solar flares

[Keitarou Matsumoto](#), [Satoshi Masuda](#), [Masumi Shimojo](#), [Hisashi Hayakawa](#)

Publ. Astron. Soc. Jpn (2023)

<https://arxiv.org/ftp/arxiv/papers/2310/2310.03135.pdf>

**23 Feb 1956**

**GLE#5**

## Revision of the strongest solar energetic particle event of 23 February 1956 (GLE #5) based on the rediscovered original records

Hisashi [Hayakawa](#)<sup>1,2,3,4</sup>, Sergey Koldobskiy<sup>5,6</sup>, Alexander Mishev<sup>5,6</sup>, Stepan Poluianov<sup>5,6</sup>, Agnieszka Gil<sup>7,8</sup>, Inna Usoskina<sup>6</sup> and Ilya Usoskin<sup>5,6</sup>  
A&A, 684, A46 (2024)

<https://www.aanda.org/articles/aa/pdf/2024/04/aa48699-23.pdf>  
<https://doi.org/10.1051/0004-6361/202348699>

## A high time-resolution analysis of the Ground-Level Enhancement (GLE) of 23 February 1956 in terms of the CSHKP standard flare model

[McCracken](#), K. G.; [Shea](#), M. A.; [Smart](#), D. F.

Advances In Space Research Volume 72 Issue 8 Page 3414-3427 2023

DOI 10.1016/j.asr.2023.06.049

<https://www.sciencedirect.com/journal/advances-in-space-research/vol/72/issue/8>  
<https://www.sciencedirect.com/science/article/pii/S0273117723005082/pdf?md5=3bd51f14d811e0a0110a075a721c3edc&pid=1-s2.0-S0273117723005082-main.pdf>

## Extreme solar particle event of 774 AD: reference as the worst-case scenario for space weather

Alexander [Mishev](#),<sup>a,b,\*</sup> Ilya Usoskina,<sup>a,b</sup> and Sanja Panovska

ICRC2023 2023

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## Relationship of peak fluxes of solar radio bursts and X-ray class of solar flares: Application to early great solar flares

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Lulu [Zhao](#), Ming Zhang, and Hamid K. Rassoul

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<https://arxiv.org/ftp/arxiv/papers/2210/2210.16693.pdf>

### **New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events**

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)  
A&A 2021

<https://arxiv.org/pdf/2101.10234.pdf>

### **Spatial Distribution of Solar Energetic Particles in the Inner Heliosphere**

Donald V. [Reames](#)<sup>1</sup>, Chee K. Ng<sup>2, 3</sup> and Allan J. Tylka  
Solar Phys., July 2013, Volume 285, Issue 1-2, pp 233-250, **File**

**1 March 1979**

### **How Do Shock Waves Define the Space-Time Structure of Gradual Solar Energetic Particle Events?** **Review**

Donald V. [Reames](#)

Space Sci. Rev 2022

<https://arxiv.org/ftp/arxiv/papers/2210/2210.16693.pdf>

### **Solar Energetic Particles and Space Weather: Science and Applications** **Review**

Olga E. [Malandraki](#) and Norma B. Crosby

In: O.E. Malandraki, N.B. Crosby (eds.), Solar Particle Radiation Storms Forecasting and Analysis  
Chapter 1, 2018

<https://link.springer.com/content/pdf/10.1007%2F978-3-319-60051-2.pdf>

**File** Malandraki\_Crosby\_SEPs\_Forecasting and Analysis\_Book.pdf

### **The Effects of Interplanetary Transport in the Event-intergrated Solar Energetic Particle Spectra**

Lulu [Zhao](#), Ming Zhang, and Hamid K. Rassoul

2017 ApJ 836 31

<http://sci-hub.cc/10.3847/1538-4357/836/1/31>

### **Spatial Distribution of Solar Energetic Particles in the Inner Heliosphere**

Donald V. [Reames](#)<sup>1</sup>, Chee K. Ng<sup>2, 3</sup> and Allan J. Tylka

Solar Phys., July 2013, Volume 285, Issue 1-2, pp 233-250, **File**

**6-7 Jun 1979**

### **Precursory Signs of Large Forbush Decreases**

M. [Papailiou](#), [M. Abunina](#), [H. Mavromichalaki](#), [A. Belov](#), [A. Abunin](#), [E. Eroshenko](#) & [V. Yanke](#)

[Solar Physics](#) volume 296, Article number: 100 (2021)

<https://link.springer.com/content/pdf/10.1007/s11207-021-01844-y.pdf>

<https://doi.org/10.1007/s11207-021-01844-y>

**21 Aug 1979 GLE#33**

### **New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events**

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)  
A&A 2021

<https://arxiv.org/pdf/2101.10234.pdf>

### **THE UNUSUAL RELATIVISTIC SOLAR PROTON EVENTS OF 1979 AUGUST 21 AND 1981 MAY 10**

E. W. [Cliver](#)

Astrophysical Journal, 639:1206–1217, 2006, File  
<http://iopscience.iop.org/article/10.1086/499765/pdf>

**19 March 1980**

**Flare Observations**

**Review**

Arnold O. **Benz**

[Living Reviews in Solar Physics](#) December 2017?, 14:2 File

This article is a revised version of <http://dx.doi.org/10.12942/lrsp-2008-1>.

<https://link.springer.com/content/pdf/10.1007%2Fs41116-016-0004-3.pdf>

**27 March 1980**

**Flare Observations**

**Review**

Arnold O. **Benz**

[Living Reviews in Solar Physics](#) December 2017?, 14:2 File

This article is a revised version of <http://dx.doi.org/10.12942/lrsp-2008-1>.

<https://link.springer.com/content/pdf/10.1007%2Fs41116-016-0004-3.pdf>

**6 Apr 1980**

**Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**1 May 1980**

**Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**21 May 1980**

**Svestka's Research: Then and Now**

**Review**

Hugh S. **Hudson**

Solar Phys. 2015

<http://arxiv.org/pdf/1503.04452v1.pdf>

**28 May 1980**

**Full inversion of solar relativistic electron events measured by the Helios spacecraft**

Daniel **Pacheco** (1), [Neus Agueda](#) (1), [Angels Aran](#) (1), [Bernd Heber](#) (2), [David Lario](#)

A&A 2019

<https://arxiv.org/pdf/1902.06602.pdf>

**The soft X-ray Neupert effect as a proxy for solar energetic particle injection**

*A proof-of-concept physics-based forecasting model*

Ruhann **Steyn**<sup>1\*</sup>, Du Toit Strauss<sup>1</sup>, Frederic Effenberger<sup>2,3</sup> and Daniel Pacheco<sup>4</sup>

J. Space Weather Space Clim. 2020, 10, 64

<https://www.swsc-journal.org/articles/swsc/pdf/2020/01/swsc200079.pdf>

**Large gradual solar energetic particle events**

**Review**

Mihir **Desai**, Joe Giacalone

Living Reviews in Solar Physics, December 2016, 13:3

<http://solarphysics.livingreviews.org/>

## Release History and Transport Parameters of Relativistic Solar Electrons Inferred From Near-the-Sun In-situ Observations

[Agueda N.](#) & [Lario D.](#)

2016 ApJ 829 131

E-print, 22 Sept 2016

**29 May 1980**

### Full inversion of solar relativistic electron events measured by the Helios spacecraft

Daniel [Pacheco](#) (1), [Neus Agueda](#) (1), [Angels Aran](#) (1), [Bernd Heber](#) (2), [David Lario](#)

A&A 2019

<https://arxiv.org/pdf/1902.06602.pdf>

**19 Jun 1980**

### Evolution of sheath and leading edge structures of interplanetary coronal mass ejections in the inner heliosphere based on Helios and Parker Solar Probe observations

Manuela [Temmer](#), [Volker Bothmer](#)

A&A 2022

<https://arxiv.org/pdf/2202.04391.pdf>

**10 Oct 1980**

### Precursory Signals of Forbush Decreases Not Connected with Shock Waves

D. [Lingri](#), [H. Mavromichalaki](#), [M. Abunina](#), [A. Belov](#), [E. Eroshenko](#), [I. Daglis](#) & [A. Abunin](#)  
[Solar Physics](#) volume 297, Article number: 24 (2022)

<https://link.springer.com/content/pdf/10.1007/s11207-022-01951-4.pdf>

**2 Nov 1980**

### Diagnosing transient plasma status: from solar atmosphere to tokamak divertor

A. S. [Giuntaa](#), S. Henderson, M. O'Mullane, J. Harrison, J. G. Doyle and H. P. Summers

2016

[http://www.arm.ac.uk/~jgd/outgoing/PAPERS/ADAS/JINST\\_077P\\_0616\\_final\\_draft.pdf](http://www.arm.ac.uk/~jgd/outgoing/PAPERS/ADAS/JINST_077P_0616_final_draft.pdf)

**11 Nov 1980**

### Solar jets: SDO and IRIS observations in the perspective of new MHD simulations

**Review**

[Brigitte Schmieder](#)

Frontiers 9:820183. 2022

doi: 10.3389/fspas.2022.820183

<https://arxiv.org/pdf/2201.11541.pdf>

<https://www.frontiersin.org/articles/10.3389/fspas.2022.820183/full>

**7 Feb 1981**

### Coronal mass ejections and their sheath regions in interplanetary space

**Review**

Emilia [Kilpua](#), Hannu E. J. Koskinen & Tuija I. Pulkkinen

Living Reviews in Solar Physics December 2017, 14:5 **File**

<https://link.springer.com/content/pdf/10.1007%2Fs41116-017-0009-6.pdf>

**25 Mar 1981**

### Solar Energetic Particle-Associated Coronal Mass Ejections Observed by the Mauna Loa Solar Observatory Mk3 and Mk4 Coronameters

I. G. [Richardson](#), [O. C. St Cyr](#), [J. T. Burkepile](#), [H. Xie](#), [B. J. Thompson](#)

Solar Phys. 2023

<https://arxiv.org/pdf/2308.10826.pdf>

**24 Apr 1981**

## Solar Gradual Hard X-Ray Bursts and Associated Phenomena

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**26 Apr 1981**

## Solar Gradual Hard X-Ray Bursts and Associated Phenomena

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**10 May 1981 GLE#35**

## New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)

A&A 2021

<https://arxiv.org/pdf/2101.10234.pdf>

## THE UNUSUAL RELATIVISTIC SOLAR PROTON EVENTS OF 1979 AUGUST 21 AND 1981 MAY 10

E. W. [Cliver](#)

Astrophysical Journal, 639:1206–1217, 2006, File

<http://iopscience.iop.org/article/10.1086/499765/pdf>

**13 May 1981**

## Solar Gradual Hard X-Ray Bursts and Associated Phenomena

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**2-4 Sep 1981**

## Precursory Signs of Large Forbush Decreases

M. [Papailiou](#), [M. Abunina](#), [H. Mavromichalaki](#), [A. Belov](#), [A. Abunin](#), [E. Eroshenko](#) & [V. Yanke](#)

[Solar Physics](#) volume 296, Article number: 100 (2021)

<https://link.springer.com/content/pdf/10.1007/s11207-021-01844-y.pdf>

<https://doi.org/10.1007/s11207-021-01844-y>

**12 Oct 1981 GLE#36**

## High-energy (>40 MeV) Proton Intensity Enhancements Associated with the Passage of Interplanetary Shocks at 1 au

D. [Lario](#)<sup>1</sup>, I. G. Richardson<sup>1,2</sup>, A. Aran<sup>3</sup>, and N. Wijsen<sup>1,2</sup>

2023 ApJ 950 89

<https://iopscience.iop.org/article/10.3847/1538-4357/acc9c5/pdf> File

## New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)

A&A 2021

<https://arxiv.org/pdf/2101.10234.pdf>

**14 Nov 1981**

**Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**5 Dec 1981**

**Space weather: the solar perspective -- an update to Schwenn (2006)**

**Review**

[Manuela Temmer](#)

Living Reviews in Solar Physics 2021

<https://arxiv.org/pdf/2104.04261.pdf>

**Coronal mass ejections and their sheath regions in interplanetary space**

**Review**

Emilia [Kilpua](#), Hannu E. J. Koskinen & Tuija I. Pulkkinen

Living Reviews in Solar Physics December 2017, 14:5 **File**

<https://link.springer.com/content/pdf/10.1007%2Fs41116-017-0009-6.pdf>

**Large gradual solar energetic particle events**

**Review**

Mihir [Desai](#), Joe Giacalone

Living Reviews in Solar Physics, December 2016, 13:3

<http://solarphysics.livingreviews.org/>

**7 March 1982**

**Large gradual solar energetic particle events**

**Review**

Mihir [Desai](#), Joe Giacalone

Living Reviews in Solar Physics, December 2016, 13:3

<http://solarphysics.livingreviews.org/>

**Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**2 June 1982**

**Full inversion of solar relativistic electron events measured by the Helios spacecraft**

Daniel [Pacheco](#) (1), [Neus Agueda](#) (1), [Angels Aran](#) (1), [Bernd Heber](#) (2), [David Lario](#)

A&A 2019

<https://arxiv.org/pdf/1902.06602.pdf>

**03-Jun-1982**

**Solar Neutron Decay Protons observed in November 7, 2004**

Yasushi [Muraki](#), [Jose F. Valde-Galicia](#), [Ernesto Ortiz](#), [Yutaka Matsubara](#), [Shoichi Shibata](#), [Takashi Sako](#), [Satoshi Masuda](#), [Munetoshi Tokumaru](#), [Tatsumi Koi](#), [Akitoshi Ooshima](#), [Takasuke Sakai](#), [Tsuguya Naito](#), [Pedro Miranda](#)

### **X-Ray, Radio and SEP Observations of Relativistic Gamma-Ray Events**

**Review**

Karl-Ludwig **Klein**, Kostas Tziotziou, Pietro Zucca, Eino Valtonen, Nicole Vilmer, Olga E. Malandraki, Clarisse Hamadache, Bernd Heber, and Jürgen Kiener

In: O.E. Malandraki, N.B. Crosby (eds.), Solar Particle Radiation Storms Forecasting and Analysis Chapter 8, 2018

<https://link.springer.com/content/pdf/10.1007%2F978-3-319-60051-2.pdf>

File Malandraki\_Crosby\_SEPs\_Forecasting and Analysis\_Book.pdf

### **The Relationship between Long-Duration Gamma-Ray Flares and Solar Cosmic Rays**

Hugh S. **Hudson**

Space Weather of the Heliosphere: Processes and Forecasts (eds. Claire Foullon and Olga Malandraki), IAU Symposium 335, 2017

<https://arxiv.org/pdf/1711.05583.pdf>

### **Neutron monitor yield function for solar neutrons: A new computation†**

A. **Artamonov**, G.L. Kovaltsov, A.L. Mishev, I.G. Usoskin

JGR 2016

### **High energy neutron and pion-decay gamma-ray emissions from solar flares**

**Review**

**Chupp**, Edward L.; Ryan, James M.

Research in Astron. Astrophys. Volume 9, Issue 1, pp. 11-40 (2009) File

<http://www.raa-journal.org/raa/index.php/raa/article/view/50/36>

<https://iopscience.iop.org/article/10.1088/1674-4527/9/1/003/pdf>

### **Long-Duration Solar Gamma-Ray Flares**

**Review**

**Ryan** J.M.

Space Science Reviews, v. 93, Issue 3/4, p. 581-610 (2000) File

<https://link.springer.com/content/pdf/10.1023%2FA%3A1026547513730.pdf>

### **On the Origin of the Pion-Decay Radiation in the 1982 June 3 Solar Flare**

**Ramaty**, R. ; **Murphy**, R. J. ; **Dermer**, C. D.

Astrophysical Journal Letters v.316, p.L41 1987

<https://articles.adsabs.harvard.edu/pdf/1987ApJ...316L..41R>

**6 Jun 1982**

### **Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

**Cliver**, E. W.; **Dennis**, B. R.; **Kiplinger**, A. L.; **Kane**, S. R.; **Neidig**, D. F.; **Sheeley**, N. R., Jr.; **Koomen**, M. J.

1986 ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**10 Jun 1982**

### **Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

**Cliver**, E. W.; **Dennis**, B. R.; **Kiplinger**, A. L.; **Kane**, S. R.; **Neidig**, D. F.; **Sheeley**, N. R., Jr.; **Koomen**, M. J.

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<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**11-14 July 1982**

## The relevance of local magnetic records when using extreme space weather events as benchmarks

Elena **Saiz\***, Consuelo Cid and Antonio Guerrero

J. Space Weather Space Clim. **2021**, 11, 35

<https://www.swsc-journal.org/articles/swsc/pdf/2021/01/swsc200104.pdf>

<https://doi.org/10.1051/swsc/2021018>

## The virtual enhancements – solar proton event radiation (VESPER) model

Sigiava **Aminalragia-Giamini**<sup>1,2\*</sup>, Ingmar Sandberg<sup>1,2</sup>, Constantinos Papadimitriou<sup>1,2</sup>, Ioannis A. Daglis<sup>1,3</sup> and Piers Jiggins

J. Space Weather Space Clim. **2018**, 8, A06

<https://www.swsc-journal.org/articles/swsc/pdf/2018/01/swsc170059.pdf>

A new probabilistic model introducing a novel paradigm for the modelling of the solar proton environment at 1 AU is presented. The virtual enhancements – solar proton event radiation model (VESPER) uses the European space agency's solar energetic particle environment modelling (SEP-EM) Reference Dataset and produces virtual time-series of proton differential fluxes. In this regard it fundamentally diverges from the approach of existing SPE models that are based on probabilistic descriptions of SPE macroscopic characteristics such as peak flux and cumulative fluence. It is shown that VESPER reproduces well the dataset characteristics it uses, and further comparisons with existing models are made with respect to their results. The production of time-series as the main output of the model opens a straightforward way for the calculation of solar proton radiation effects in terms of time-series and the pairing with effects caused by trapped radiation and galactic cosmic rays. **11-14 Jul 1982, 27-Nov-1989 to 05-Dec-1989**

**13-14 July 1982**

## Coronal mass ejections and their sheath regions in interplanetary space

**Review**

Emilia **Kilpua**, Hannu E. J. Koskinen & Tuija I. Pulkkinen

Living Reviews in Solar Physics December **2017**, 14:5 **File**

<https://link.springer.com/content/pdf/10.1007%2Fs41116-017-0009-6.pdf>

**13-16 Aug 1982**

## Space weather: the solar perspective -- an update to Schwenn (2006)

**Review**

**Manuela Temmer**

Living Reviews in Solar Physics **2021**

<https://arxiv.org/pdf/2104.04261.pdf>

**14 Aug 1982**

## Coronal mass ejections and their sheath regions in interplanetary space

**Review**

Emilia **Kilpua**, Hannu E. J. Koskinen & Tuija I. Pulkkinen

Living Reviews in Solar Physics December **2017**, 14:5 **File**

<https://link.springer.com/content/pdf/10.1007%2Fs41116-017-0009-6.pdf>

## Large gradual solar energetic particle events

**Review**

Mihir **Desai**, Joe Giacalone

Living Reviews in Solar Physics, December **2016**, 13:3

<http://solarphysics.livingreviews.org/>

**26 Nov 1982 GLE#37**

## New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events

Sergey A. **Koldobskiy**, **Osku Raukunen**, **Rami Vainio**, **Gennady A. Kovaltsov**, **Ilya G. Usoskin**

A&A **2021**

<https://arxiv.org/pdf/2101.10234.pdf>

**7 Dec 1982 GLE#38**

### **The time profile of relativistic solar particle events as observed by neutron monitors**

Sophie [Musset](#)<sup>1</sup>, Karl-Ludwig Klein<sup>2\*</sup>, Nicolas Fuller<sup>2</sup>, Gaelle Khreich<sup>2,3</sup> and Antonin Wargnier<sup>2</sup>  
J. Space Weather Space Clim. **2023**, 13, 15

<https://www.swsc-journal.org/articles/swsc/pdf/2023/01/swsc220075.pdf>

### **New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events**

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)  
A&A **2021**

<https://arxiv.org/pdf/2101.10234.pdf>

### **Hard x-ray spectroscopy for proton flare prediction**

[Garcia](#), Howard A. ; [Farnik, Frantisek](#) ; [Kiplinger, Alan L.](#)

Proc. SPIE Vol. 3442, p. 210-216, **1998**, Missions to the Sun II, Clarence M. Korendyke; Ed.

<https://doi.org/10.1117/12.330259>

<https://sci-hub.ru/10.1117/12.330259>

### **Comparative Studies of Hard X-Ray Spectral Evolution in Solar Flares with High-Energy Proton Events Observed at Earth**

[Kiplinger, Alan L.](#)

Astrophysical Journal v.453, p.973, **1995**

<https://articles.adsabs.harvard.edu/pdf/1995ApJ...453..973K>

**17 Dec 1982**

### **Solar Gradual Hard X-Ray Bursts and Associated Phenomena**

[Cliver, E. W.](#); [Dennis, B. R.](#); [Kiplinger, A. L.](#); [Kane, S. R.](#); [Neidig, D. F.](#); [Sheeley, N. R., Jr.](#); [Koomen, M. J.](#)

**1986** ApJ...305..920-935

<http://articles.adsabs.harvard.edu/full/1986ApJ...305..920C>

DOI: [10.1086/164306](https://doi.org/10.1086/164306)

**25-29 Dec 1982**

### **Large gradual solar energetic particle events**

**Review**

Mihir [Desai](#), Joe Giacalone

Living Reviews in Solar Physics, December **2016**, 13:3

<http://solarphysics.livingreviews.org/>

**14 Feb 1983**

### **Toward GIC Forecasting: Statistical Downscaling of the Geomagnetic Field to Improve Geoelectric Field Forecasts**

[C. Haines](#), [M. J. Owens](#), [L. Barnard](#), [M. Lockwood](#), [C. D. Beggan](#), [A. W. P. Thomson](#), [N. C. Rogers](#)

Space Weather [Volume20, Issue1](#) January **2022** e2021SW002903

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2021SW002903>

<https://doi.org/10.1029/2021SW002903>

**13 May 1983**

### **Comparative Studies of Hard X-Ray Spectral Evolution in Solar Flares with High-Energy Proton Events Observed at Earth**

[Kiplinger, Alan L.](#)

Astrophysical Journal v.453, p.973, **1995**

<https://articles.adsabs.harvard.edu/pdf/1995ApJ...453..973K>

**2 Feb 1984 GLE#39**

## Modelling the transport of relativistic solar protons along a heliospheric current sheet during historic GLE events

Charlotte O. G. [Waterfall](#), [Silvia Dalla](#), [Timo Laitinen](#), [Adam Hutchinson](#), [Mike Marsh](#)

ApJ 2022

<https://arxiv.org/pdf/2206.11650.pdf> File

**16 Feb 1984 (GLE#39 ?)**

## New reconstruction of event-integrated spectra (spectral fluences) for major solar energetic particle events

Sergey A. [Koldobskiy](#), [Osku Raukunen](#), [Rami Vainio](#), [Gennady A. Kovaltsov](#), [Ilya G. Usoskin](#)

A&A 2021

<https://arxiv.org/pdf/2101.10234.pdf>

**2 Aug 1985**

## Incoherent Solar Radio Emission

**Review**

[A. Nindos](#)

Frontiers in Astronomy, Space Sciences 2020,

<https://arxiv.org/pdf/2007.14888.pdf>

<https://doi.org/10.3389/fspas.2020.00057>

<https://www.frontiersin.org/articles/10.3389/fspas.2020.00057/full>

**5 Dec 1985** large SEP event from filament eruption

## Solar filament eruptions and energetic particle events

[Kahler](#), S.W., Cliver, E.W., Cane, H.V., McGuire, R.E., Stone, R.G., Sheeley, N.R., Jr.: 1986, *Astrophys. J.* 302, 504, DOI:10.1086/164009.

**3 Feb 1986**

## Flare Observations

**Review**

Arnold O. [Benz](#)

[Living Reviews in Solar Physics](#) December 2017?, 14:2 File

This article is a revised version of <http://dx.doi.org/10.12942/lrsp-2008-1>.

<https://link.springer.com/content/pdf/10.1007%2Fs41116-016-0004-3.pdf>

**14 Feb 1986**

## Solar flares, coronal mass ejections and solar energetic particle event characteristics

Athanasios [Papaioannou](#)<sup>1\*</sup>, Ingmar Sandberg<sup>1</sup>, Anastasios Anastasiadis<sup>1</sup>, Athanasios Kouloumvakos<sup>2</sup>, Manolis K. Georgoulis<sup>3</sup>, Kostas Tziotziou<sup>1,3</sup>, Georgia Tsiropoula<sup>1</sup>, Piers Jiggins<sup>4</sup> and Alain Hilgers

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[Nicola Plutino](#), [Francesco Berrilli](#), [Dario Del Moro](#), [Luca Giovannelli](#)

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**David H. Boteler**, [Shibaji Chakraborty](#), [Xueling Shi](#), [Michael D. Hartinger](#), [Xuan Wang](#)

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Alexander [Mishev](#),*a,b,\** Ilya Usoskina,*a,b* and Sanja Panovska

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Ashraf [Moradi](#)<sup>1</sup> and Joe Giacalone<sup>1</sup>

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Ashraf [Moradi](#)<sup>1</sup> and Joe Giacalone<sup>1</sup>

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