Space weather in the popular media, and the opportunities the upcoming solar maximum brings

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Key Points:

- Solar maximum is approaching, and so are opportunities to publicize space weather in popular media
- Public interest in space weather increases with space weather activity
- Space weather researchers are encouraged to engage with the media and to prepare by taking advantage of media training resources

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Abstract
(and PLS)

The media interest/coverage of space weather has been increasing as we approach solar maximum and the private space industry has grown significantly since the last significant solar maximum in 2000–2002. It is not uncommon for space weather media coverage to use hyperbole with frequent references to the infamous 'Carrington event'. The implications of associating each of the many upcoming moderate-to-severe storms with the Carrington event are discussed, and we encourage the curbing of hyperbole whenever possible. While there is an excellent but small cohort of space weather researchers actively engaging with the media, we urge more (particularly early-to-mid career) to take advantage of media training resources and to join in. We also call for these efforts to be broadly supported by peers and institutions for the benefit of space weather as a discipline.

1 Introduction

As the maximum of solar cycle 25 fast approaches, we already see an increase in significant space weather events. We can expect a further increase in the frequency of such events, along with an increase in media interest in space weather. This can be beneficial in many ways:

- It can help build the professional profiles of researchers and that of the institutions in which they work;
- It can provide an accessible format for key decision and policy makers;
- It can also lead to an increase of the awareness of space weather throughout society, and consequently an increase in the number of students who enter into this field.

Given that the majority of the current funding that supports space weather research comes from tax payers, the increase in media exposure is both beneficial to the overall research and is a way to give back to the community.

Compared to other areas of science, space weather is not a topic of heated public debate that is laden with controversies and widespread misinformation, such as climate science and medicine. However, space weather does have a tendency to be portrayed in popular media using hyperbole, which is arguably our field's biggest challenge when it comes to its public profile. At times, this can lead to researchers from adjacent fields playing down the real impacts of space weather, and indirectly diminishing the importance of space weather research. So, striking the right balance is very important.

The 1859 Carrington event is perhaps the clearest example of an extreme space weather event in modern history. The widespread impacts on telegraph infrastructure, the very low-latitude aurora sightings around the world, in combination with very few observations in the 1800s make that event mysterious and interesting, for researchers and non-researchers alike. Adding to the intrigue of the Carrington event is the fact that human technology has since become so advanced, and that such an event could have catastrophic consequences for the way we live (National Research Council, 2008). While such extreme events are of course *very* rare (there is active research to determine where it falls within the one-in-a 100 year to one-in-a 1000 year category, e.g., Riley & Love, 2017; Love, 2020), mentions of the Carrington event can be commonplace in popular media coverage of space weather events. However, we now have several decades of significant events that have had significant impacts to which we can point (e.g., Allen et al., 1989; Doherty et al., 2004; Baker et al., 2013; Knipp et al., 2016, 2018; Redmon et al., 2018; Hapgood, 2019;

Boteler, 2019; Hapgood et al., 2022). We even have the loss of a Starlink deployment from recent moderate storm (Fang et al., 2022).

We can wonder "why is regularly recalling the Carrington event an issue for the field of space weather?" Well, due to the rarity of such extreme space weather events, playing the 'Carrington card' too often could come across as 'crying wolf', which could have direct implications for the field in terms of public reputation, preparedness and mitigation strategies, and of course, funding levels. At the same time, 'what if' scenarios for extreme space weather events are important to address when discussing space weather in popular media, but it is also important that each event that comes along not be mistakenly tagged as 'the big one'.

Why is hyperbole so often used when covering space weather in popular media? One reason could be related to how online traffic influences editorial decisions (e.g., Anderson, 2011). There are numerous cases of well-informed and balanced space weather media articles that contain rather alarmist headlines that appear to be aimed at attracting audiences; in some cases, the articles have been reposted under modified titles. This tendency to invoke hyperbole provides insights into the high pressures that journalists and editors can face in their jobs (e.g. Peters, 2008). As space weather scientists, it is important for us to provide calm, measured and professional insights into space weather and its implications, based on the scientific literature. However, such tapering of hyperbole in popular media cannot be achieved unless space weather researchers are visible and accessible to the journalists seeking expert input.

While many of us manage some social media presence online, research has found that most scientists use it to engage with each other, and only those that reach a following of 1000+ tend to break through to a broader/popular audience (Côté & Darling, 2018). While some space weather scientists have arguably broken through this barrier (and are doing an excellent job), there are still many that have not. Journalists tend to approach researchers that are highly visible, increasing their exposure, thus creating a feedback loop of media presence (Peters, 2008). Space weather needs more researchers that are active within this feedback loop to ensure that the field is appropriately represented in popular media and to help moderate how space weather is portrayed.

An argument could be made that 'any publicity is good publicity', and if peer-reviewed papers that attract 'comment' papers can be used as a reliable analog for hyperbolic popular media articles, this argument could indeed hold true (e.g., Radicchi, 2012). However, while publicity might be good for the field, crying wolf too often for missed or weak events, may result in a general distrust of the scientific approach, effects which may be more detrimental overall than any positive effects. How and when to provide this balance is not straight forward. It is also not clear how much time should be devoted to this task, since public outreach, and citizen science participation in (social) media is generally not considered for promotion at the same level as "traditional" academic research (Gruzd et al., 2011). In addition to this, increasing the number of science communicators with sufficient knowledge in space weather would surely help.

2 What is the public's appetite for space weather content?

Without access to detailed metrics for multiple popular science media outlets, it is difficult to gauge when the public's interest in space weather peaks and wanes. However, analyzing the data provided by Google Trends can provide some insights.

Figure 1 shows the relative number of Google News searches for the specific terms "geomagnetic storms", "northern lights", "space weather", "solar storm" and "southern lights" over the past 5 years. For reference, the weekly maxima for the Kp and F10.7 indices are shown; geomagnetic storms of $Kp \geq 6$ are shown in black.

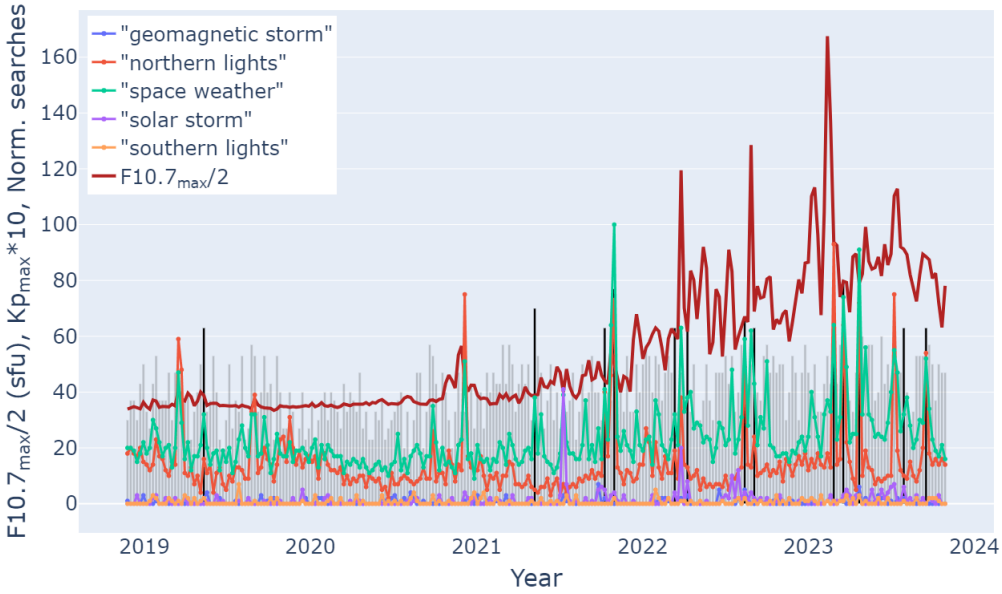

Figure 1. The normalized occurrence of Google News searches for "geomagnetic storms", "northern lights", "space weather", "solar storm" and "southern lights" over the past 5 years. Also plotted are the weekly maxima of the Kp index (Kp_{max}) * 10 in grey and the F10.7 index ($F10.7_{max}$)/2 in dark red. Weeks that had a $Kp_{max} \geq 6$ are plotted in black.

As one may have hypothesized, the frequency of Google News searches relating to space weather have been increasing with solar activity, particularly in the last 24 months. It can also be seen that there are a number of spikes in Google News search activity specifically relating to "space weather" and "northern lights" during the weeks of significant storms; e.g., February, March and April in 2023. The spike in searches in late 2020 that is not accompanied by a geomagnetic storm relates to a CME that missed Earth. The low numbers for "southern lights" searches is most likely due to the much smaller global population in the southern hemisphere. The low numbers for search terms "geomagnetic storm" and "solar storm" could be an indication that these terms are not as well associated with space weather activity by lay people. The "space weather" and "northern lights" search activity could indeed be primarily driven by aurora hunters/photographers that can span from lay people to full-blown experts. Searches for "aurora" were also analyzed, but this contained far too many searches that were not related to space weather to be included.

Among the many conclusions that could be drawn from these data, this plot indicates that the appetite for space weather knowledge peaks whenever there is some anticipated, or actual, geomagnetic activity. Importantly, these data only relate to user-driven searches, and not by the presence of advertisements/prompts. So knowledge of the space weather activity must have come to them beforehand by some other means. To this end, it is encouraging that this initial information is getting out to the broader population. The popularity of the term "northern lights" is also a very clear indication of what excites people about space weather enough to directly search for it online.

3 A call to arms

Now that we understand that there is some appetite for space weather news articles when significant space weather events occur, whose job is it to answer media requests? It is typical for younger researchers to avoid the media spotlight (e.g., Besley et al., 2018), for many obvious reasons. A combination of less experience, imposter syndrome and a lack of influence over the final media piece and what happens to it after publication (e.g. Peters, 2008) all make for a very risky venture that could poorly reflect on a researcher in the eyes of their more senior peers. However, the space weather community is far smaller compared to other science disciplines, and we need a more active media presence when space weather reaches the popular news. One part of addressing this is for more space weather scientists to raise their hand/answer the call, but we also need to better support early and mid-career researchers who wish to contribute.

The solar cycle maximum is coming, so space weather scientists need to get prepared.

- For those that are interested in helping reshape the way space weather is covered in popular media, spruce up your online presence, and acquaint yourself with your institution's press office and any available media assistance/training. Community-based media training programs also exist, for example AGU's "Voices for Science" program; https://www.agu.org/honors/voices-for-science. Having an experienced mentor can also be tremendously valuable.
- Science communication is time consuming, as it takes training and preparation to be done effectively. As such, it is important for our field to be represented by a critical mass of visible, accessible and available space weather scientists to help carry the load. It is also important for institutions to consider and reward the work that goes into science communication for promotion.
- Science communication is also very difficult to get right, given the lack of influence scientists have over use of quotes, article titles, final edits etc. (e.g., Peters, 2008). Framing is important for helping steer the journalist and/or the audience towards a factual and meaningful understanding, and utilizing media training/resources can help in this regard. However, while researchers might be effective in framing the significance/impact of a given space weather event and avoiding hyperbole, it does not mean that the journalists and editors (who often control what the heading is) will adhere. So, it is important for everyone in the field to recognize these challenges and to be considerate of each other when coverage is not ideal. Instead, we should better support each other when such instances occur, particularly early and mid-career space weather researchers. We all benefit from the promotion of space weather to the wider community.
- More science communicators should be fostered in the space weather field. Also, science communicators should feel confident to tame down the hyperbole and educate themselves on the weaker impacts associated with moderate-to-intense space weather events. For this, the space weather scales used by various space weather prediction agencies around the world are a valuable resource. We also have several events over recent decades (including moderate-to-severe) that have had significant real-world impacts to which we can point, so the space weather impacts discussion need not be hypothetical.

Space weather scientists need to engage with the media and the wider public as space weather activity increases over the next few years. Let's be ready to take advantage of the opportunities that the Sun will soon provide us.

4 Open Research

Google Trends data was obtained from https://trends.google.com/trends/. The Kp and F10.7 data were obtained from NASA's OMNIWeb service (Papitashvili & King, 2020); originally made available courtesy of GFZ Potsdam (https://kp.gfz-potsdam.de/en/data) and the National Research Council Canada in partnership with the Natural Resources Canada (https://www.spaceweather.gc.ca/forecast-prevision/solar-solaire/solarflux/sx-en.php), respectively. The specific data used here are available on the Zenodo data repository (Carter, 2023).

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