Space Weather News on the Web at NICT

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Extremely fast CME was ejected by the solar flare in October 2003, and caused space environment disturbances. Low latitude aurora was observed in the northern part of Japan. These space storms and accidents on Japanese satellites were reported on TV news and newspapers. In order to inform public people of the space storms and hazards on the satellite system, the space weather group of the NICT started to issue the Space Weather News (http://swnews.nict.go.jp/) on October 29, 2003. The space weather news has been published everyday for one year and ten months. The total access count has reached about 500,000 in August 2005. The average daily access count is about 1,050 in the last three months. The space weather news is accessed by researchers and professionals in space science and technology as well as by the public.

Keywords
Space weather, Web publishing, Geomagnetic storm, Solar flare

1 Introduction

On Oct. 24, 2003, a power failure experienced by the Midori II Advanced Earth Observation Satellite II (ADEOS-II) shortly after the arrival of shock waves created by a solar wind caused a complete shutdown of the satellite's functions. Then, on Oct. 28, the third-largest solar flare on record as of that date occurred on the surface of the Sun, and abnormal signals were reported in the solar sensors of the KODAMA Data Relay Test Satellite (DRTS). In the days that followed, strong (and record-breaking) disturbances were observed in the solar terrestrial environment, including the fifth-largest solar proton event (corresponding to an immense increase in solar radiation) and the fifth-largest geomagnetic storm recorded as of that date. With the development of the geomagnetic storm, auroral activities spread to extremely low-latitude regions around the world, and in Japan, low-latitude auroras were observed widely in the Hokkaido and central Honshu regions.

These events led to extensive reports in the newspapers and elsewhere on space-weather disturbances, and the Space Weather Group was inundated with requests for information both from the media and the public.

Up to that time, the Space Weather Group of the National Institute of Information and Communications Technology (NICT; previously the Communications Research Laboratory, or CRL) had released information on the solar terrestrial environment by telephone, fax, e-mail, and on our website. However, the content was generally aimed at specialists and was difficult to comprehend for the general reader. This enormous disturbance raised our awareness of the need to expand our targets of information to include the general public, leading us to create a new website, the "Space Weather News".

2 Policies of the space weather news publication

The Space Weather News was founded based on the following policies.

- Provision of information to those in the general public with no professional knowledge
- Use of simple expressions and eye-catching images
- Daily issuance and prompt updates in the event of large-scale events, through "news flashes"
- Presentation of information on space weather and instructions on viewing the data to familiarize readers with the subject

The first step in creating such a website involved determining the level of understanding when assuming a general public audience. If the target readership is too broad and the website rendered comprehensible to anyone, we will find ourselves unable to use almost any technical terms, inhibiting the effective relay of information. Therefore, we decided to target readers with some interest in space weather and who are willing to learn the technical terms they may find initially difficult to understand.

In many cases, disturbances in space weather are sudden events, with long stretches of quiet periods. Therefore, if articles were to be written only on disturbances, updates would be sporadic and could confuse readers as to how frequently the site is in fact revised. We believe that with daily updates—even on minor matters—readers will be encouraged to visit the site every day. We have therefore decided to issue the news on a daily basis. In fact, quiet periods can be viewed as consisting of events leading up to the next disturbance, and our policy to release information daily ultimately proved a significant means of predicting future developments and large-scale space weather events, based on data gathered during such periods.

The primary purpose of the Space Weather News is to increase the number of people familiar with space weather phenomena. Therefore, efforts must be aimed at attracting reader interest and stimulating the desire to learn more. Thus, we believe it is important to provide not only current space weather information, but also to provide the background information that will help the reader understand current conditions, such as the details and causes of a given event and future predictions. Detailed explanations could easily become too extensive and bog the writer down, but we nevertheless plan to provide as much information as possible, so that our readers will ultimately find themselves knowing a great deal about space weather simply by virtue of reading our news over a period of time. On the other hand, we also plan to make the website visually pleasing, offering stunning photo and video images of the Sun and auroras, rendering the site attractive to readers who do not necessarily understand all of the content—readers who, we believe, also form an important element of our readership.

3 Space weather news content

The Space Weather News covers information on the overall environment from the Sun to the Earth. Figure 1 is an example of a page from the news. The page is split vertically, with the narrow left-hand and the wide right-hand margins providing information and general PR items, respectively. The wide right-hand column first presents a summary of the space weather for the day, and then offers plots of observation data and images provided by various organizations. News updates are made semi-automatically using a PC and so the page design will generally remain unchanged; this is necessary to provide a manageable workload for the writers who prepare the news. The narrow left-hand column provides tables on the latest space weather data, the results of auto-analysis, and links to useful sites that will help the reader gain a greater understanding of space weather.

Articles can generally be grouped into those dealing with the Sun, with solar winds, and with the magnetosphere.

Information on the Sun includes changes

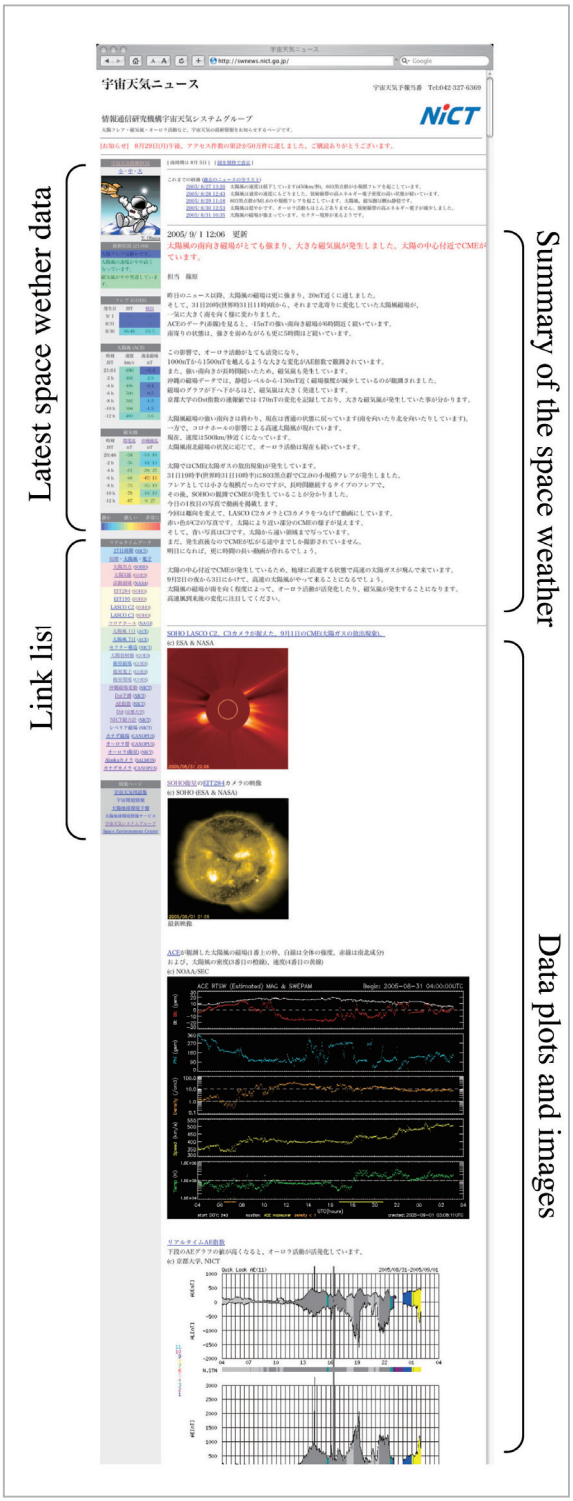

Fig. 1 *Page from Space Weather News, issued on Sept. 1, 2005.*

Data provided by ESA & NASA for SOHO and NOAA/SEC for ACE

in sunspot groups, occurrences of solar flares, occurrences of CME (coronal mass ejection), and distribution of coronal holes, as well as the results of analysis of these phenomena.

The flow of plasma released by the Sun is referred to as the solar wind, and the velocity of the solar wind and characteristics of the accompanying magnetic field control the amount of electromagnetic energy that enters the magnetosphere. This in turn affects the activities in the magnetosphere of the Earth. Data from solar wind observation satellites is used to determine the characteristics of the solar winds and to predict the effects of these winds on the Earth's magnetosphere. In the event of sudden occurrences such as CMEs, judgments are made on the possibility of effects to the Earth, as well as estimations on the arrival time of the high-velocity solar wind. Since the rotational period of the Sun is 27 days, regular ejections of high-velocity solar winds by coronal holes tend to recur in 27-day cycles, and this characteristic is used in discussing short-term (e.g., weekly) predictions.

Information on the Earth's magnetosphere includes assessments of the occurrence and development of auroras and geomagnetic storms. Events that are likely to affect the operation of satellites are also reported, including changes in the high-energy electron density of the radiation belt and solar proton events associated with strong solar flares.

An abundance of attractive photo and video images are also presented to draw in the general reader, including photos of solar flares and CME gas ejections taken by various solar observation satellites (SOHO, GOES) as well as photos of auroras taken by NICT's Alaska Project team and auroral observation satellites. When low-latitude auroras were observed, we also presented photos contributed by readers. We have been told that a planetarium at a science museum in Shikoku prints out the Space Weather News every day as a part of its general exhibition, to increase space weather awareness among visitors during the summer vacation. We believe that attractive images incorporated in the news will have strong appeal among visitors in these and similar efforts.

4 Hits to date

Publication of the Space Weather News began on Oct. 29, 2003. At the time, solar activities and magnetospheric activities were extremely strong and the site had to be updated frequently. Space weather conditions calmed down eventually, and since then, updates have generally been made once a day. From inception to Aug. 21, 2005 (663 days), 665 news articles were issued, with a total of 488,739 hits. The average number of hits for the three-month period from May to August 2005 stood at 1,046 per day. The cumulative total is expected to exceed 500,000 by the end of Aug. 2005.

4.1 Trends in website access

Figure 2 shows the growth in the number of viewers accessing the site. The horizontal axis shows the months from Nov. 2003, the start of publication, to Sept. 2005. Since the graph shows the cumulative total, the plot is basically an upward-sloping curve. However, it can be seen that the slope gradually becomes steeper with time, indicating an increase in the daily number of hits. Several jumps are observed in the curve, indicating concentrated access within short periods attributable to large-scale space weather disturbances.

Figure 3(b) shows the change in the daily number of hits. During the half-year period from inception to July 2004, this daily number remained between 300–500. The number of hits then increased dramatically within a short period at the time indicated by the arrow in the graph. This corresponds to a period of significant increases in solar flare activity, which caused large space weather disturbances such as geomagnetic storms and low-latitude auroras.

Figure 3(a) shows variations in the Dst index, one of the indicators representing the characteristics of the Earth's magnetosphere, with values corresponding to the strength of the ring current flowing around the Earth. Negative-trending changes in values of the Dst index indicate the development of a geomagnetic storm, and a significant decrease in the Dst plot indicates the occurrence of a large-scale geomagnetic storm. The arrows in Fig. 3 indicate significant negative changes in Dst values, all of which correspond to large-scale space weather disturbances.

The occurrence of these large-scale disturbances resulted in a sudden increase in hits due to more frequent visits by regular readers and also due to an influx of new readers who were introduced to our Space Weather News

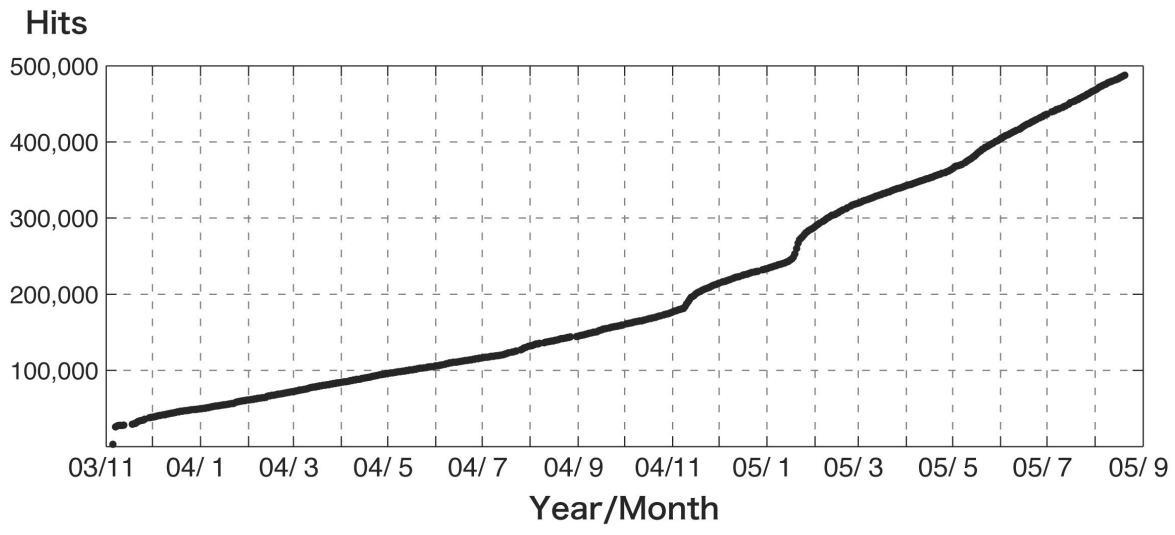

Fig.2 *Cumulative total number of hits for Space Weather News*

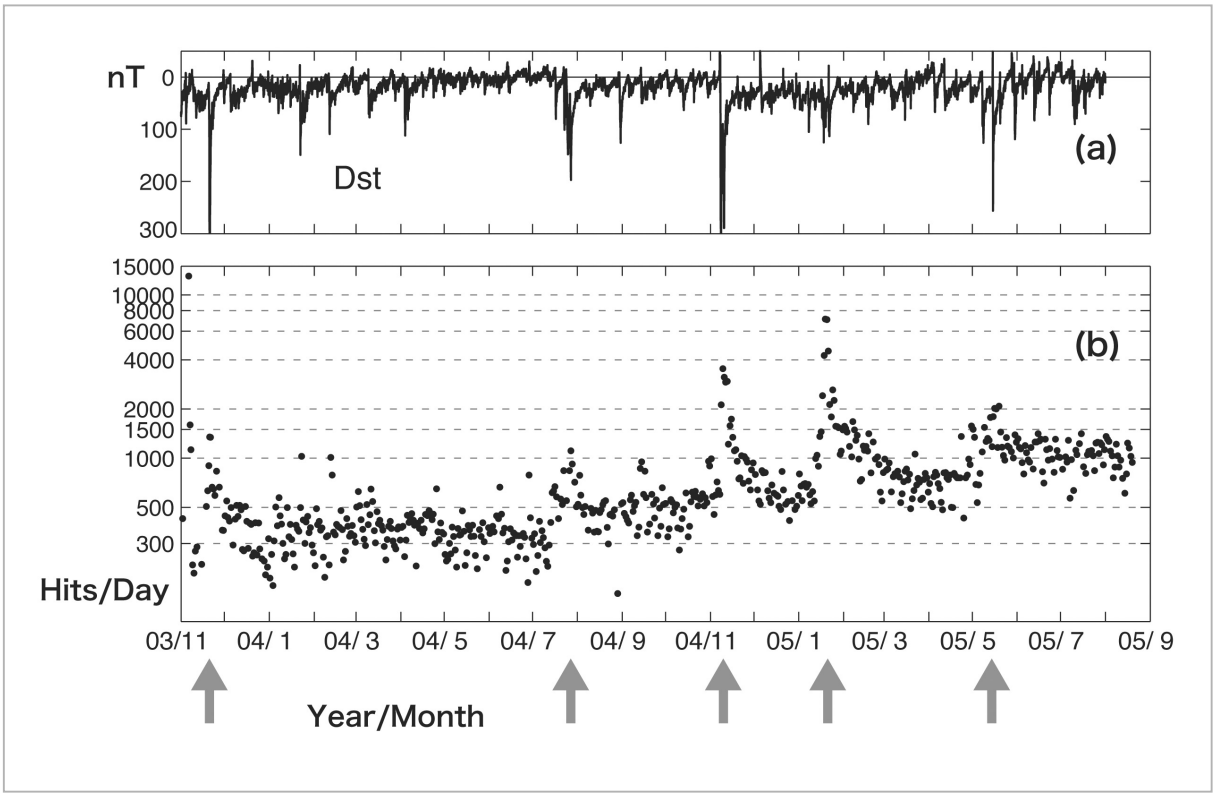

Fig.3 *Dst index (a) and number of hits per day to the Space Weather News (b)*

site on the web. It was particularly noted that a mention of our site in the online media results in an explosive jump in the number of hits. In Nov. 2003, there were 23,000 hits to the site concentrated within a two-day period, and in Jan. 2005, the number of concentrated hits totaled 14,000 for another two-day period. Although the sudden increase in user access falls off as a disturbance dies down, it appears that a portion of new visitors stay on to become regular readers, as indicated by the increase in average number of hits after the points indicated by the arrows.

In the final three-month period shown in Fig. 3(b), we see approximately 1,050 hits per day, a value 2.5 times greater than that seen at the outset.

4.2 Trends in regular access

Figure 4 shows the average number of hits per hour for each day based on data collected for 91 days from May 22 to Aug. 20, 2005. The hits are distributed fairly evenly between 8 a.m. and midnight. We see 60 hits per hour—thus, one visitor per minute. The general increase between noon and 1 p.m. is most likely due to lunchtime visitors. The number of hits falls significantly at night, and the quietest periods occur in the three-hour period between 3 a.m. and 6 a.m. However, access continues to some degree even in the late night and early morning hours.

Figure 5 shows the average number of hits per day on a weekly basis. The gathered data

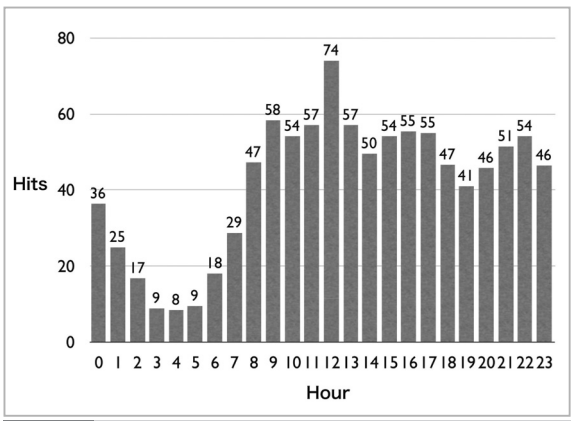

Fig.4 *Average number of hits per hour for each day*

corresponds to the same time period as indicated in Fig. 4. There is a clear difference in the number of hits on weekdays and on weekends, with user access increasing by approximately 20% during the week, and an average of 1,070 and 820 hits on weekdays and weekends, respectively. There are no apparent differences in the number of hits among weekdays or between Saturdays and Sundays.

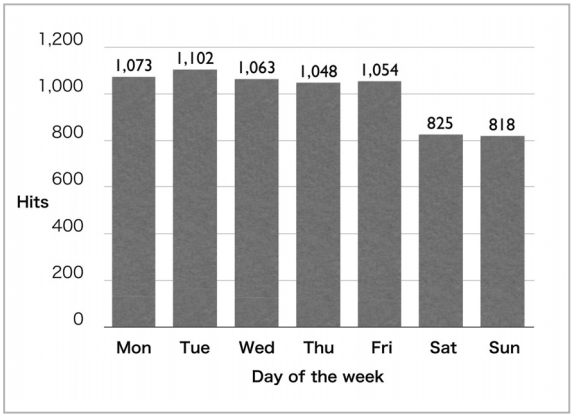

Fig.5 *Average number of hits per day on a weekly basis*

5 Readership

We have analyzed our readership based on the access log. Based on domain names, the visits were traced and largely categorized as coming from:

- Educational institutions
- Government and research organizations
- Private businesses
- Provider companies

These categories include groups that are believed to be directly associated with space weather fields as well as those that have no direct connection to these areas.

Provider company access is believed to consist mainly of visits from general household users, leading us to conclude that we have been successful in our initial aim of establishing a body of general readers who read the Space Weather News out of personal interest.

Universities and technical colleges are found among the records of access by educational institutions. There is almost no access from high schools and below, but this may be due to the fact that these institutions do not appear separately as they generally do not make use of independent domains.

Organizations that are deeply involved in space-related activities, such as those operating satellites, largely form the group of governmental and research organizations accessing the site. Particularly, we see a number of organizations associated with GPS management.

Companies involved in satellite operations, broadcasting, electric power supply, and electronics form the bulk of private-business access. We believe that in many of these cases, the information provided is in fact essential in the business operations of these companies.

Although the Space Weather News was launched to increase public interest in space weather, it seems that we have also gained the support of those who require such information in the course of their business activities, exceeding our initial audience expectations. By focusing site content on explanations of space weather phenomena, we may have succeeded in establishing a truly balanced site, providing information both for amateurs and professionals (the latter of which had, before this project, been served primarily by the Space Weather Group).

6 Evaluation as a website

Websites that exist in a vacuum never succeed in gaining a wide audience, and so efforts must be made to increase readership through links with various websites and search-engine hits.

Two surveys have been conducted to evaluate the success of the Space Weather News website throughout the world. The first consisted of a survey on the types of websites that linked to our site, and the second survey looked at our page ranking in search results using several key terms on engines such as Google. Since links between sites are essential in website promotion, it is believed that the

results of these two surveys can provide some indication of external evaluations of our site.

Based on a variety of data on pages with links to our site, we found two types of links—one in which links are presented on pages directly associated with space weather as part of their business activities, and one consisting of links from sites indicating ours as a target of personal interest.

Examples of linked sites that regard our information as commercially useful include:

- Those introducing the characteristics of shortwave broadcasting hazards
- Those cautioning visitors on increased positioning errors in GPS
- Those introducing our site as reference source for news related to space weather in the web media

Shortwave broadcasting is directly affected by space weather conditions such as ionospheric disturbances. Although we had been aware of GPS vulnerability to ionospheric disturbances, we did not expect that those managing such systems took space weather conditions into consideration on the application level. This is one case in which we learned something new from our users about the dissemination of space weather information. We have concluded that mentions of our site in web media were significantly enhanced by our targeting of content to the general reader.

The links from individual-user websites can be further divided into the categories below.

- those interested in auroras
- ham radio operators
- those generally interested in space-related topics
- those interested in earthquake prediction and similar uses

The number of people interested in auroras is on the rise due to an increase in participants of "aurora viewing tours" in Canada and Alaska, and in fact this number appears to be quite significant. These people, who are interested in the live aurora camera under the NICT Alaska Project, are probably highly interested in the pages of website dealing with auroras.

The first three groups were to be expected, but the fourth came as a complete surprise. Based on an assessment of these websites, it appears that space weather conditions are viewed as necessary data in assessing the occurrence of a variety of natural phenomena. Some of these sites focus directly on space weather disturbances, while others view these as factors that must be taken into consideration in light of their effects on the observation of other phenomena. Along with the example of the use of space weather data in GPS operation, the fourth case proves that such use is not necessarily limited to the applications we anticipated. The lesson we have drawn here is that the active dissemination of information can lead us to attract unexpected new groups of users.

The order of relevance in the search-engine results was investigated using Google, presently the most popular such engine. The following words were used in association with the phrase "Space Weather News" (in Japanese).

"Space weather":	1st
"Space":	31st
"Weather":	39th
"News":	96th
"Space" and "weather":	4th
"Space" and "news":	4th

These search results were obtained on Aug. 21, 2005.

Our Space Weather News site is at the top of the search results for "space weather", indicating that our site is the most significant in relevance among the websites for this phrase. A search using such general terms as "space", "weather", or "news" also produces results in which our site ranks highly in relevance. In particular, there are a great number of sites that handle "news", including mainstream media sites, but even here we have ranked 96th, indicating that Google recognizes our site as having significant relevance. Our site also ranks highly in search results using combinations of words such as "space" and "news" or "weather" and "news". Analysis of our logs shows that some visitors were

serendipitously guided to Space Weather News through search results using such general terms. These fortuitous links may also play a vital role in promoting our site.

7 Use as a reference source

Nearly two years have passed since the launch of the Space Weather News site. Since then, we have seen numerous active space weather disturbances, and though unintended, the regular duties of site operation have led to an accumulation of daily records of such events in text and data. The accumulated material has begun to take on significance as a reference source, and its role as a library of space weather records is beginning to take form.

Several presentations on flares and geomagnetic storms from 2003–2004 given at the 2005 Japan Joint Meeting for Earth and Planetary Sciences have cited the Space Weather News as one of their references. Since figures and images, with comments for each, are collected on a single site on a daily basis, the Space Weather News now appears to be a useful research library. Here we have yet another example of an unanticipated use.

The value of Space Weather News as a source of information will only increase with future issues. It goes without saying that accordingly we must take care in writing the most accurate and concise articles.

8 Conclusions

With the intense space weather disturbances from Oct.–Nov. 2003, the Space Weather Group launched a new site, the "Space Weather News", providing articles on space weather for the general reader. Placing priority on being an interesting read for the non-professional, the site presents explanations of observation data and space weather predictions along with stunning images of the Sun and auroral events.

In the one year and 10 months since its launch to Aug. 2005, we have continued to provide information on a daily basis and have achieved a stable readership exceeding 1,000 hits per day and a cumulative total of nearly 500,000 cases of user access. We can safely conclude based on the extent of our readership that the Space Weather News has succeeded in becoming a leading page for the dissemination of scientific information.

Progress in space-based initiatives from satellites to space stations, the widespread use of satellite technologies such as satellite broadcasting and GPS, the popularity of "aurora viewing tours", and the launch of commercial space trips (though still extremely expensive) have rapidly increased the presence of space weather in the public consciousness. The field is presently acknowledged in a wide range of media, and we believe that growing number of hits to the Space Weather News site provides a clear reflection of these societal trends. Our access records strongly indicate that space weather information is not only sought for professional use, but that there are many in the general population who either require this information or are simply interested enough to seek it out.

Solar activity follows an 11-year cycle, and so our Space Weather News cannot be regarded as having run a full course until its first 11-year cycle is completed. Thus, our chief goal at present is to continue publication through 2014.

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