System for Issuing and Distributing Space-Weather Reports

Tsutomu NAGATSUMA

A space weather report is issued by Hiraiso Solar Terrestrial Research Center every Friday and whenever a severe space weather disturbance occurs. This report was provided specified users by facsimile. We have developed a system for issuing the report and distributing it on the WWW (World Wide Web) and by e-mail. This system is based on an original CGI script of the server-client type for issuing, freeware programs (procmail), (majordomo) for filtering e-mails, and user registration and e-mail distribution functions.

Keywords
space weather report, solar flare, geomagnetic disturbance, e-mail automatic distribution

1 Introduction

The Hiraiso Solar Observatory, as one of the Regional Warning Centers of the international organization known as ISES (the International Space Environment Service), carries out forecasting operations, acquiring and analyzing large amounts of solar-terrestrial data; information concerning the current conditions of space-weather disturbances (such as solar flares, geomagnetic storms, and solar proton events) and related developments are provided to users on a daily basis[1]. From April, 2000 onward, four groups - the Sun and Solar Wind Group (the Hiraiso Solar Observatory), the Space-Weather Group, the Simulator Group, and the Ionosphere and Radio Propagation Group, have taken charge of their respective operations.

The space-weather report got off the ground in 1979 as an information service intended specifically for space-weather clients. The purpose of the service is to summarize the general conditions relating to solar phenomena, geomagnetic disturbances, and so on, and to discuss future developments, all in a brief report. The space-weather report is normally officially issued every Friday after the forecasters meeting, and is also issued on special occasions, as when there are large solar flares, geomagnetic storms, or proton events. The official report had been distributed to a few dozen organizations, such as affiliated institutions and universities, via facsimile. At first, forecast documents were handwritten, and were later drafted using word-processing software.

Following the explosive popularization of the Internet, the WWW (World Wide Web) and e-mail have come to be readily used as means of transmitting information. Previously, the Hiraiso Observatory had been providing an on-line space environment information service called the Space Environment Real-time Data Intercommunication Network (SERDIN/text) via telnet, but at the beginning of the 1990's, in consideration of the Internet trend, it developed and implemented the space environment information service on the WWW (SERDIN/WWW)[2]. As a result a variety of information, and not just text, can be provided to numerous untargeted users.

However, the SERDIN/WWW had conventionally focused on allowing the user to

directly access the forecast data which was collected for making forecast judgement, rather than providing a large number of users with the advanced information. It was only through GEOALERT that the Hiraiso Observatory's forecast judgments concerning future developments of general conditions were provided. Therefore, it was requested that the service be enhanced, so as to be able to provide the space-weather report to numerous undetermined space-weather users.

Information distribution by facsimile does not require specified maintenance of the system and hence can be used in a simple and easy way. On the other hand, because it takes a long time to send a single piece of information, there occurs a large time delay before the information is transmitted to the final user, when the number of distribution destinations becomes greater. This represents a serious drawback of this information transfer method, in the event of a severe space-weather disturbance requiring rapid reporting. Therefore, the conventional method created difficulties in broadening the user base.

In light of this situation, to enrich the information provided and to diversify information distribution, we developed our system for issuing and distributing space-weather reports. This system assists the forecaster in inputting the forecast documents and, after completion of input, automatically executes registration of the forecast documents with the SERDIN/WWW and e-mail distributions. Moreover, the system was designed to significantly reduce the forecaster's work.

2 System concept

The system for issuing and distributing space-weather reports adopted a client-server system that used a proven Web server program (httpd), developed for the SERDIN/WWW, as an interface. This method enables the server to manage file registration and e-mail distribution uniformly; at the same time, any computers equipped with a Web browser capable of accessing the server may act as the forecast input terminal (client). Therefore, it was determined that the sentence structure of the forecast documents would be described in HTML (Hypertext Markup Language). HTML is used for specifying the structures of headers, footers, titles, paragraphs, itemized sentences, and so on, which are commonly used in the documents. Each element is specified by a code, called its "tag."

The substance of this system consists of the CGI (Common Gateway Interface) scripts of the recursive type, described in the perl language. The CGI of the recursive type has an advantage in that uniform management of programs can be conducted, resulting in ease of maintenance. To construct scripts of the recursive type, a template for the document structure of the space-weather report is composed with the HTML tags; each informational element is abstracted with a variable. Given this structure, processing of input, confirmation, and registration can be executed by using the same program recursively in such a way that the contents of the variables are substituted appropriately. By substituting a tag for sentence input (< INPUT>, <TEXTAREA >, etc.) for each variable, a sentence-input screen is created and displayed. Further, when the forecaster replaces text for each tag for sentence input on this sentence-input screen, each tag is substituted with each element of the entered text, and an input-confirmation screen is then displayed, through which the forecaster can confirm the input content etc. Moreover, by switching the "file handle" from standard output to a predetermined file, the template and input content can be preserved as an HTML file. Table 1 shows the relationships among the template, the file handle, and the variable content for each function.

The forecaster can activate the server programs by invoking CGIs in the form of the URL (Uniform Resource Locators), as described below, from an arbitrary terminal. The CGIs possess the following four "invoking formats," and each function is executed according to each invoking format. The CGIs that the forecaster actually invokes are only

Table 1 *The relationships among the template, the file handle, and the variable for each function*

function	forecast document input	confirmation	file registration	e-mail distribution
template	for HTML	for HTML	for HTML	for e-mail
file handle	standard output	standard output	file	temporary file
content of variable	tag for input	text (+ tag)	text (+ tag)	text

the CGIs of the upper two formats; the CGIs in the lower two formats are invoked not by the forecaster but by the processing program, recursively.

http://$machine_name/cgi-bin/stefout/: input of the forecast documents (weekly report)
http://$machine_name/cgi-bin/stefout/SPORADIC/: input of the forecast documents (special space-weather report)
http://$machine_name/cgi-bin/stefout/PREVIEW/: confirmation of the input content of the forecast documents
http://$machine_name/cgi-bin/stefout/SUBMIT/: file registration and e-mail distribution of the forecast documents
(*$machine_name* is an address of the computer.)

3 Flow of system operation

The screen change process and the processing flow within this system are shown in Fig. 1. The server program is activated by the forecaster in the form of either of the weekly report or the special space-weather report and the input screen (Fig. 2) is displayed. On this screen, entry fields whose inputs are necessary for preparing the space-weather report are indicated as blank columns. The forecaster enters the content of the forecast and related data in the blank columns. Formats for the weekly report and for the special space-weather report differ only in the entry fields for blank columns and their number; there are no functional differences. When the "Input confirmed" button is clicked after input of the forecast content is completed, the same CGI is invoked again, assuming the format of the URL for confirmation of the input content of the forecast documents. An HTML FORM tag is used to enable the forecaster to input and transfer parameters. Since POST is specified as the attribute of METHOD of the FORM tag, the content entered on the forecast document input screen is transferred to the next process (input content confirmation) via standard input. Incidentally, if there remains an entry field in which the forecaster failed to enter information, a tag that indicates missing data and a character string ("NODATA") are automatically substituted with the variable.

The server program being invoked again displays the input-confirmation screen at the standard output, based on the input content variables that were transferred (Fig. 3). If an entry field lacks information, its location is

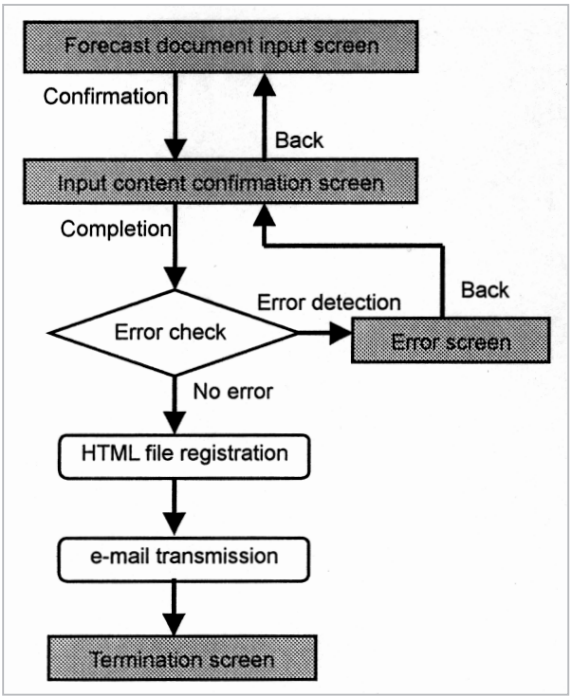

Fig. 1 *Flow of the system for issuing and distributing space-weather reports*

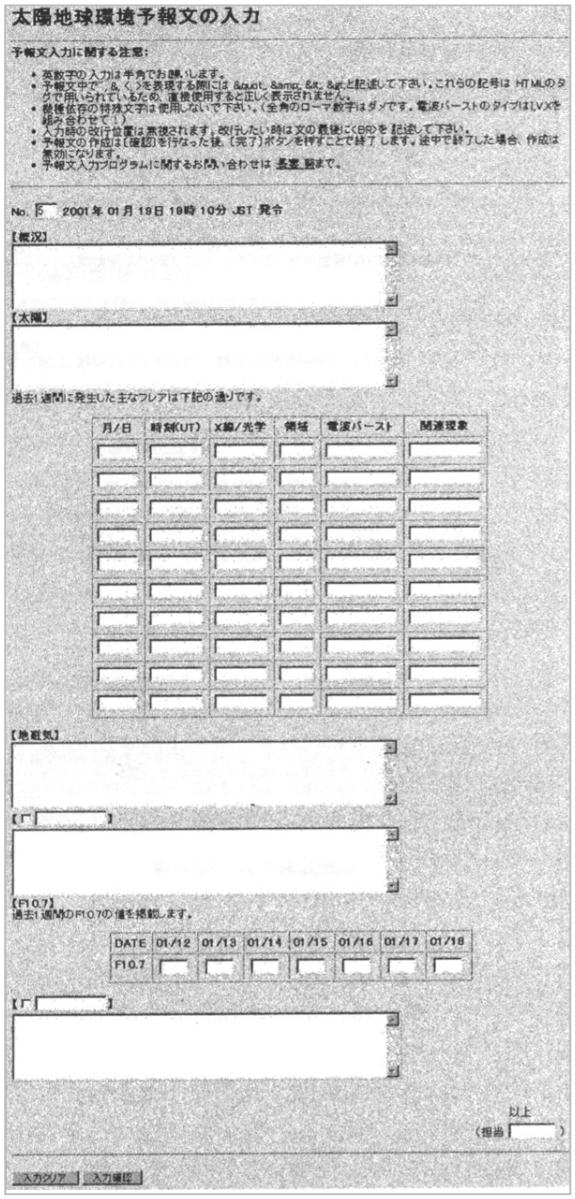

Fig.2 *Input screen displayed on a Web browser*

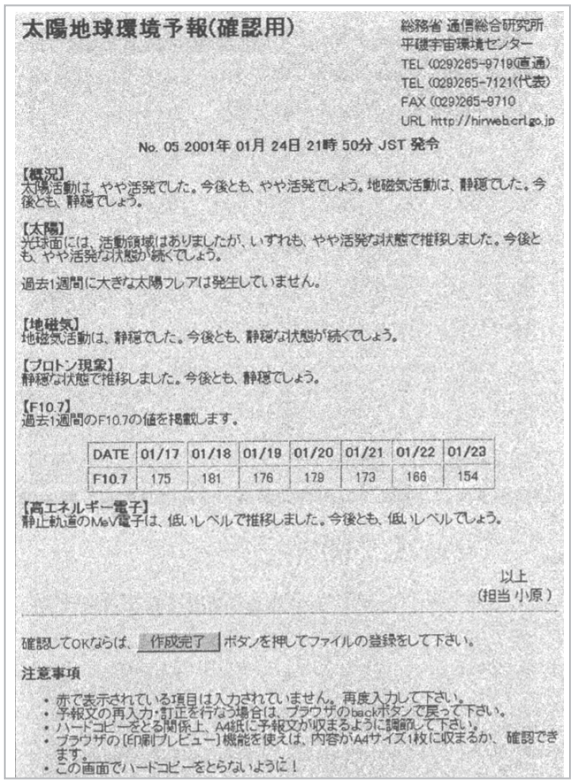

Fig.3 *Input-confirmation screen displayed on a Web browser*

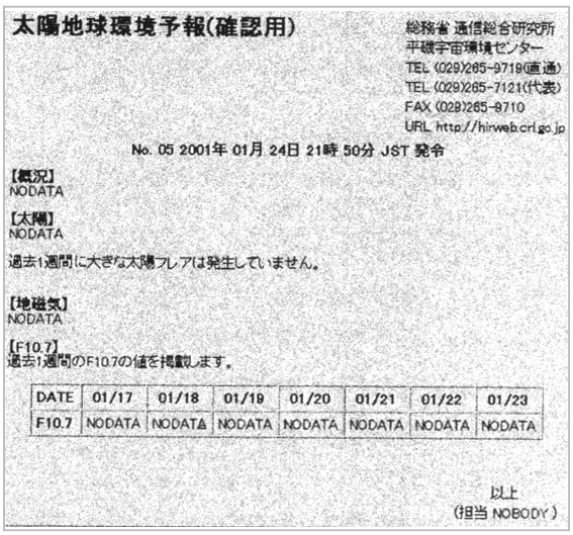

Fig.4 *Input-confirmation screen displayed on a Web browser (when a required entry field lacks data)*

indicated by a string of characters ("NODATA") and a tag, both indicated in red (Fig. 4). If a column is to be altered or filled in, the forecaster is expected to go back to the input screen by clicking the "Back" button on the browser and to make the necessary changes.

When the "Preparation completed" button is clicked after confirmation of the input content, the same CGI (in the URL format) is invoked again, to register the forecast document as a file and to allow distribution of the e-mail. In the process of file registration and e-mail distribution, an error check is conducted, and if necessary information is missing, an error screen is displayed (Fig. 5). When all the elements of required information are provided, the file handle is switched from the standard output to the file, and file registration is executed. After file registration and e-mail distribution is completed, a termination screen, indicating completion of the task, is displayed (Fig. 6). As this screen has a link to

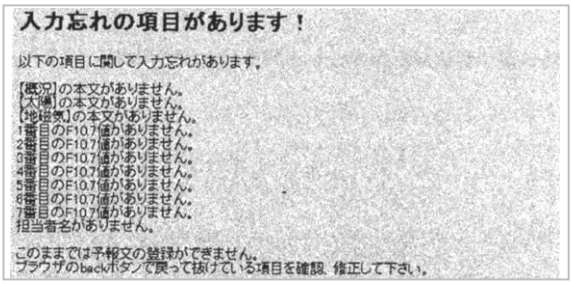

Fig.5 *Error screen displayed on a Web browser*

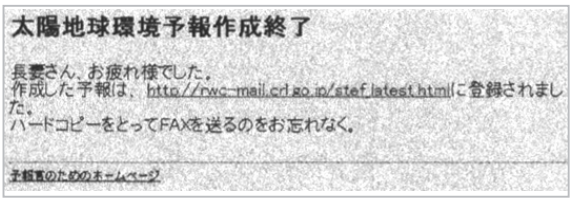

Fig.6 *Termination screen displayed on a Web browser*

the registered file, the forecaster can confirm the contents of the file as so registered and may obtain a hard copy thereof.

Further, when required information is missing, the error screen is displayed. In this case, unless the forecaster goes back to the input screen using the "Back" command on the Web browser and inputs the missing information, the file registration and e-mail distribution are not executed.

4 Making the space-weather report public using the WWW

The space-weather report that was created using the assisted-generation function is then used to overwrite on the previous HTML file for the space-weather report prepared at SERDIN/WWW, and is made public on the same URL. The address is as follows:
http://crlhir.crl.go.jp/forecast/stef_latest.html

At this point, a back-number file is also created.

An example of the space-weather report opened on SERDIN/WWW is shown in Fig. 7. Regarding a layout and a format of the screen, the conventional format of the space-weather report is followed [refer to Fig. 2 of reference literature [1]].

The space-weather report is designed to provide the general space-weather conditions

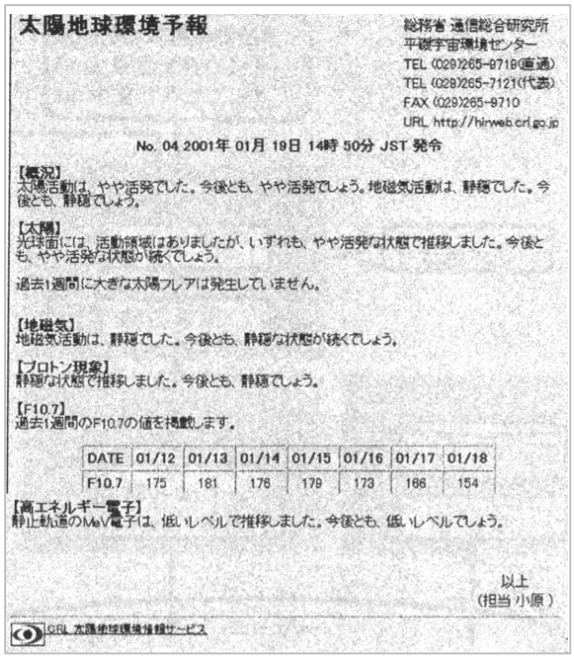

Fig.7 *An example of the space-weather report opened on the WWW*

and forecast information using quick look data and information acquired in quasi-real time. Subsequently the quick look data and information go through calibration, correction, and error correction, to become "final data." Therefore, there may be cases where final-data information differs from the content of the space-weather report. Due to this fact, the back numbers were at first intentionally made inaccessible. However, we received a lot of feedback from users indicating that, in cases where forecasts were frequently issued (along with frequent occurrences of severe space-weather disturbances), the users often failed to receive much of the information without access to the back numbers. This was inconvenient. To cope with this problem, a different CGI script was used beginning in August, 2000, to span links to the back numbers (limited to the last three months), to allow the user to access these files. The address is as follows:
http://crlhir.crl.go.jp/cgi-bin/prevhswr.pl

5 Distribution of the space-weather report by e-mail

E-mail, as a means of information trans-

mission, has recently seen its users increase rapidly in number, in conjunction with the popularization of the Internet. Mail magazines and the like, through which information is distributed periodically for registered users, (as in the system currently under discussion), are becoming more and more popular. On the other hand, there have been a number of unfortunate incidents, caused by e-mail "bomb attacks" and computer viruses; this is because vast quantities of e-mails can be sent to numerous unspecified addresses with minimal effort (for examples see http://www.cert.org). The present system takes the following two points into consideration in implementing the distribution of the space-weather report by e-mail.

Secured system safety and reliability: The system must not allow intentional e-mail "bomb attacks" and erroneous e-mails from the users to intermingle with the automatic distribution process.

Reduction of administrative work: The system permits the user to register the user's e-mail address freely, without requiring a system administrator intervene in the process.

An e-mail transmission process in this system, designed based on these requirements, is as follows (Fig. 8).

5.1 E-mail transmission from the input-assistance function to an intermediate account

In this system, after the process of registering the forecast document at SERDIN/WWW, the HTML tags are extracted from the respective variables into which the forecast documents were substituted, and the variables are spread on a template for e-mail transmission, to create a text file. The text so created is transmitted to an intermediate account (hswr-ml@rwc-mail.crl.go.jp) by using the "sendmail" command. In order to conceal an execution account of the system for issuing and distributing space-weather reports from the outside, a false e-mail address (hswr@rwc-mail.crl.go.jp) is described in the "From" field of the relayed mail.

5.2 Filtering of e-mails at the intermediate account

The e-mail distributed to the intermediate account undergoes filtering. As filtering software for e-mail, "procmail" (http://www.procmail.org/) is used. The procmail can select only space-weather report e-mails from among those that have been sent, according to a preset filtering rule. The space-weather report e-mail so selected is then transferred to the distribution account. When e-mails other than space-weather report e-mails are sent to that account, they are uniformly discarded. A benefit of using the intermediate account is that the account explicitly opened to the user as a destination ("To:") of the original space-weather report is only this intermediate account, and hence the actual distribution account can be concealed. Since any unauthorized e-mails sent to the intermediate account erroneously (or intentionally) are discarded through the filtering process, distribution of such e-mails to users cannot occur.

5.3 E-mail transmission to the distribution account

The space-weather report transferred to the distribution account is distributed to a collection of e-mail addresses that have been registered in a predetermined list file by the "alias" function of "sendmail." To automate registration and administrative work of the e-mail addresses in the list file, "majordomo" (http://www.greatcircle.com/majordomo/), a common software program for mailing lists, is used.

Any user who wishes to receive distribution of the space-weather report can register the user's address in the list file automatically by transmitting the e-mail to "ml-service@rwc-mail.crl.go.jp." For example, if a user with the "denpa_taro@crl.go.jp" e-mail address wishes to receive the distribution, all that the user has to do is simply send an e-mail containing the following sentence to "ml- service@rwc-mail. crl.go.jp":

subscribe hswr-ml denpa_taro@crl.go.jp

Using this procedure, the e-mail address

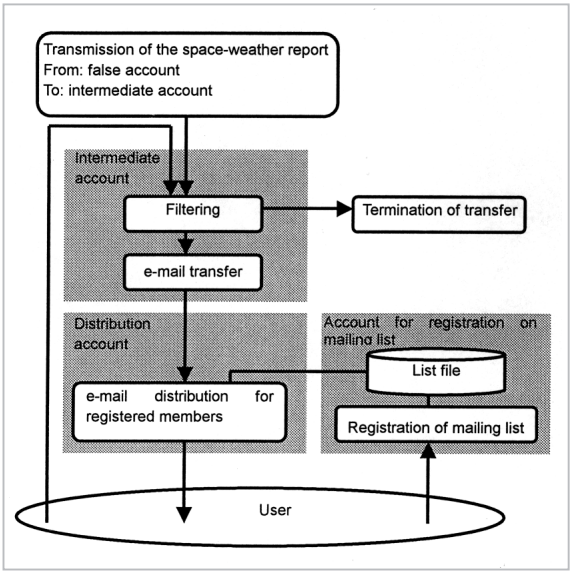

Fig.8 *Distribution process of the space-weather report by e-mail*

(in this case, "denpa_taro@crl.go.jp") is added to the list file. When the user wishes to stop the distribution of the space-weather report, all that the user has to do is send an e-mail containing the following sentence to "ml-service @rwc-mail.crl.go.jp" :

unsubscribe hswr-ml denpa_taro@crl.go.jp

Using this procedure, the e-mail address (in this case, "denpa_taro@crl.go.jp") is deleted from the list file.

6 State of use up to the present

Nearly three years have passed since the space-weather report was first made public on the WWW and by means of e-mail. For reference, the change in the number of the users (from the start of the new service through the present) was studied. Monthly changes in the total access count for the Web page of the space-weather report are shown in Fig. 9. Since April 17, 1998, the space-weather report on the WWW has been public. The figure indicates that after commencement of the new service, the access count increased steadily, reaching a count of 1,600 in December 2000. Moreover, there were remarkable increases in the access count in June and in July 2000. This phenomenon may be attributed to the following. Our center, as well as the SEC/

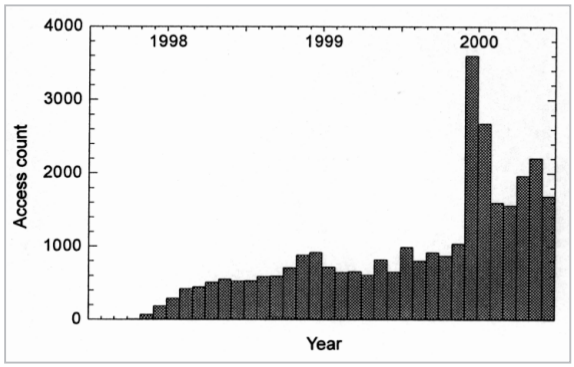

Fig.9 *Change in the total access count to the space-weather report posted on the WWW*

NOAA individually, predicted that there were possibilities that large geomagnetic storms would occur on June 8-9 and on July 15-16, and pointed out that there were possibilities that communication failure and artificial satellite troubles would occur along with these storms. This forecast was seized upon by the mass media, and there occurred abrupt increases in the number of users consulting the space-weather report during these periods.

In particular, on July 14-16, 2000, there occurred an extremely strong solar proton event and a large geomagentic storm whose Dst index exceeded -300 nT, and simultaneously events were reported such as decreases in the output of the solar-cell panels of artificial satellites and temporary attitude-controlling difficulties in the scientific satellite "ASCA." The Hiraiso Observatory also issued a special flash report to provide space-weather information expeditiously.

Next, the change in the number of registered users (i.e., subscribers) of the space-weather forecast distributed by e-mail is shown in Fig. 10. Regarding the e-mail distribution service, from commencement through December 1998, operations had been tentative, aimed at limited members of universities and research institutions associated with the space-weather forecast. From January, 1999, a notice for user registration was made public on the Web page of the space-weather database (http://hirweb.crl.go.jp/index-j.html) and elsewhere, and full-scale operation ensued. As a result, the number of the users keeps

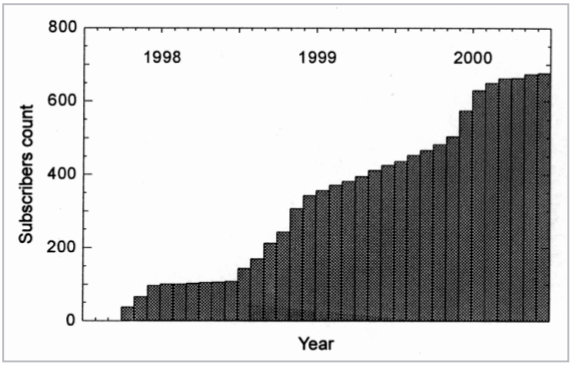

Fig.10 *Change in the number of the subscribers to the space-weather report by e-mail*

increasing, amounting to nearly 700 members as of December 2000. It is thought that the increases in June and in July 2000, as well as the increases in Web-page access, are attributable to the geomagnetic storms occurring during these periods. Considering that the number of distribution addresses of the conventional space-weather report by facsimile amounted to forty-six addresses as of December 2000, the number of the users of the new service demonstrates a rapid increase, both via the WWW page and by e-mail.

7 Summary

By virtue of the realization of the system for issuing and distributing space-weather reports, the space-weather report that was previously provided only for specified users via facsimile now can be provided for general users via the WWW and by e-mail, without increasing the workload of the forecasters. These services are steadily obtaining users. However, as the developments in information and telecommunications technologies of recent years are so striking, it cannot be denied that the present means of providing information will be outdated within a few years. Further, it is thought that, along with progress in space development and applications, and advances in research in the space-weather field, the quantity of information required by, and supplied to, space-weather users will keep growing. Therefore, we must be open to new information and to new means of transmitting such information, based on the growing needs of space-weather service users and in conjunction with trends in information and telecommunications technologies.

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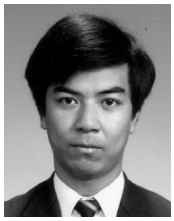

***Tsutomu NAGATSUMA**, Dr.Sci.*
Senior Researcher, Space Weather Group, Applied Research and Standards Division
Solar-Terrestrial Physics