Backup Communication Routing Through Internet Satellite, WINDS for Transmitting of Disaster Relief Data

Countermeasure for Round Trip Delay which occurs in between Satellite and Ground with Network Accelerator

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***Abstract*—A countermeasure for round trip delay which occurs in between satellite and ground with network accelerator is investigated together with operating system dependency on effectiveness of accelerator. Also disaster relief data transmission experiments are conducted for mitigation of disaster together with acceleration of disaster related data transmission between local government and disaster prevention center. Disaster relief information including remote sensing satellite images and information from the disaster occurred areas to local government for creation of evacuation information is accelerated so that it becomes possible to send them to the residents in the suffered areas due to disaster through data broadcasting in the digital TV channel.**

Keywords-internet satellite; disaster mitigation; TCP/IP protocol; accerelator.

I. INTRODUCTION

Satellite communication is widely used [1], [2]. In particular, Internet communication is also widely used through geostationary satellites [3], [4].

Japanese first Internet communication satellite: WINDS[1] was launched and put into the geostationary orbit in 2010. Since then, many experiments with the satellite have been conducted to demonstrate usefulness and effectiveness of the satellite for e-learning among the Asian countries, disaster mitigation, and distance medicine etc.

One of the major problems on the WINDS satellite is delay time in the TCP/IP communications. Round trip time between the geostationary orbit altitude and the ground is 0.6 seconds. Other than this, there is 0.2 seconds of delay time in the repeater of ATM Switcher [2] onboard WINDS satellite. Therefore, the delay time may affect to the throughput, in particular, due to the IP communication protocol (Acknowledge communications). There is another influence due to the packet window size. When the window size is fixed and small, then influence on throughput is large.

In order to overcome such influences, hardware accelerator gives a solution. Hardware accelerator allows adjustment of the window size then throughput is recovered in somehow. Some experiments have been conducted for confirmation of the effect of hardware accelerator with WINDS satellite. Also an attempt has been made for creation of software accelerator[3] in order to provide more flexibility as well as reduce the manufacturing cost.

Next section describes the configuration and procedure of the experiments with WINDS satellite followed by scientific purpose of the experiment of disaster relief data transmissions for disaster mitigation. Then the proposed software accelerator is described with conclusion and some discussions.

II. EXPERIEMTS WITH WINDS SATELLITE

A. System Configuration

Fig.1 shows the configuration of the experiments with WINDS satellite. There are three sites of transmitting and receiving stations. Any station may transmit and receive data through WINDS satellite. SkyX[4] of hardware accelerator is employed at the stations as shown in Fig.2.

Under the antenna, there is low noise amplifier and down convertor. After that the received data are sent to the SkyX through outdoor unit and indoor unit. Then work station or PC receives the data through router and switching HUB.

[1] http://www.jaxa.jp/countdown/f14/special/column_j.html

[2] http://www.cisco.com/en/US/products/hw/switches/ps718/products_command_reference_chapter09186a00800f025b.html

[3] http://www.brothersoft.com/downloads/network-accelerator.html
http://www.softpedia.com/get/Tweak/Network-Tweak/Cloud-Drive-Network-Accelerator.shtml

[4] http://www.netone.co.jp/seminar/tfa9q100000031eb-att/06DSE_SkyX.pdf

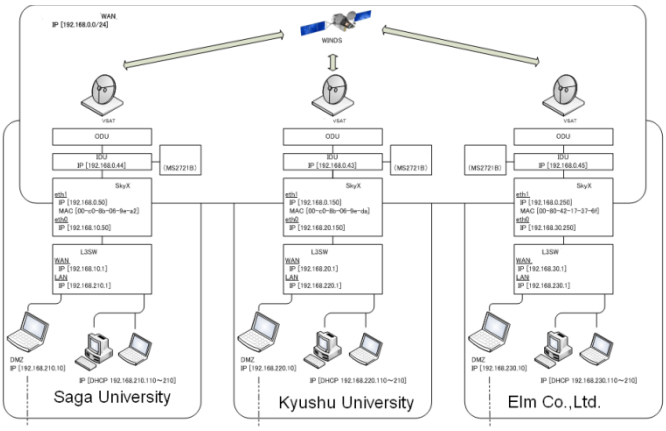


Figure 1. Configuration for the experiments with WINDS satellite.

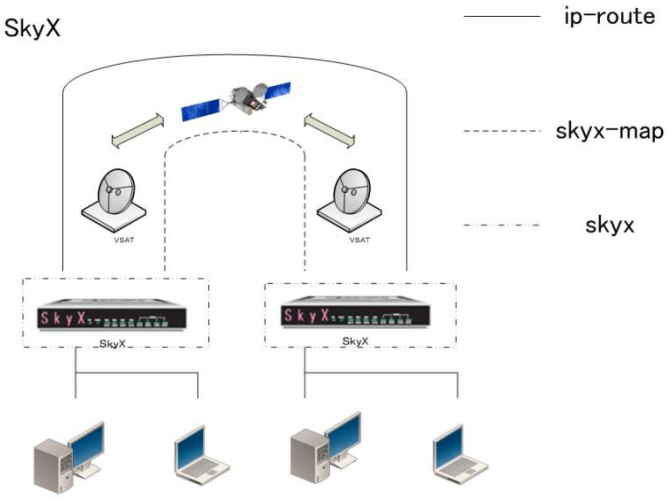


Figure 2. SkyX setup configurations

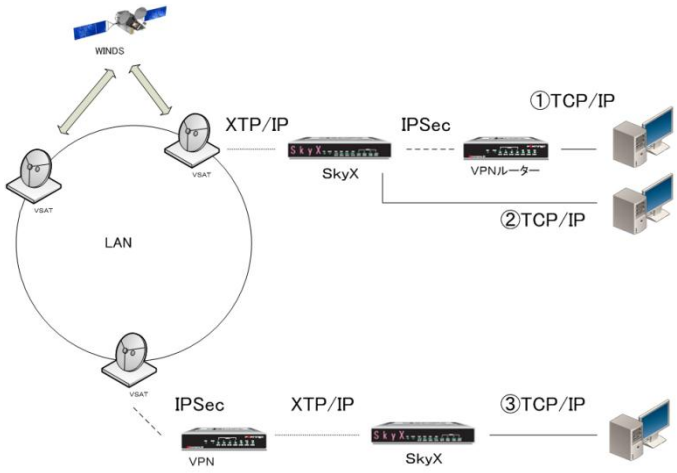


Figure 3. Some configurations do not work.

SkyX does not work because TCP/IP packets is sent to receiver through VPN router with tunneling on IPsec[5], ① and ② does not work. On the other hand, SkyX does work for this configuration. It is meaningless because VPN[6] is constructed Under the WINDS-VSAT[7] network, SkyX is valid though.

B. *Experimental Results on ftp Transmission*

Ftp data transmission experiments are conducted with the following conditions, (1) Data rate for uplink: 51 MBps, (2) Output power is set for data transmission of 30 MBps without any packet losses. The experimental results are shown in Table 1. As the result, it is found that ftp transmission with SkyX is125 time faster than that without SkyX

TABLE 1. FTP DATA TRANSMISSION EXPERIMENTAL RESULTS

SkyX ON File: WindsTestSmall.dat (1079064 bytes)		
Sender/Receiver	Time(s)	Data rate(Kbytes/sec)
Kyushu U.←Saga U.	1.06	1016.07
Saga U.←Kyushu U.	1.08	1000.99
SkyX OFF File: WindsTestSmall.dat (1079064 bytes)		
Sender/Receiver	Time(s)	Data rate(Kbytes/sec)
Kyushu U.←Saga U.	129.92	8.31
Saga U.←Kyushu U.	146.63	7.36
SkyX ON File: WindsTest.dat (310677846 bytes)		
Sender/Receiver	Time(s)	Data rate(Kbytes/sec)
Kyushu U.←Saga U.	84.61	3671.88
Saga U.←Kyushu U.	75.94	4091.20

C. *OS Dependency*

In order to check OS dependency, Microsoft Windows OS of VISTA and XP are tested for comparison with the ftp transmission of WindsTestSmall.dat (1079064 bytes). Table 2 shows the results.

It is confirmed that Auto Tuning function included in the Windows Vista does work for acceleration of ftp data transmission through TCP/IP protocol. Data transmission rate is improved by 4.97 time for Windows VISTA in comparison to the Windows XP.

D. *Data Transmission Experiments for Disatser Mitigation*

Data transmission experiments for disaster mitigation are conducted with MODIS[8] satellite data and disaster relieved data with MODIS through TCP/IP and UDP[9] protocols with and without SkyX.

[5] http://searchmidmarketsecurity.techtarget.com/definition/IPsec

[6] http://strongvpn.com/GC_packages_japan.shtml?gclid=CMu4k56k6KoCFQZhgwodJF9S9g

[7] http://en.wikipedia.org/wiki/Very_small_aperture_terminal

[8] http://modis.gsfc.nasa.gov/

[9] http://tsunami-udp.sourceforge.net/

TABLE 2. COMPARISON OF FTP DATA TRANSMISSION PERFORMANCE BETWEEN WINDOWS VISTA AND XP.

Vista-Vista:SkyX ON 1.33sec 813.77 kbyte/sec
Vista-Vista:SkyX OFF 29.56sec 36.54 kbyte/sec
XP-XP:SkyX OFF 146.85sec 7.4 kbyte/sec
Vista-Vista:SkyX OFF 29.56sec 36.54 kbyte/sec

Fig.4 shows examples of MODIS data and MODIS derived disaster relieved data.

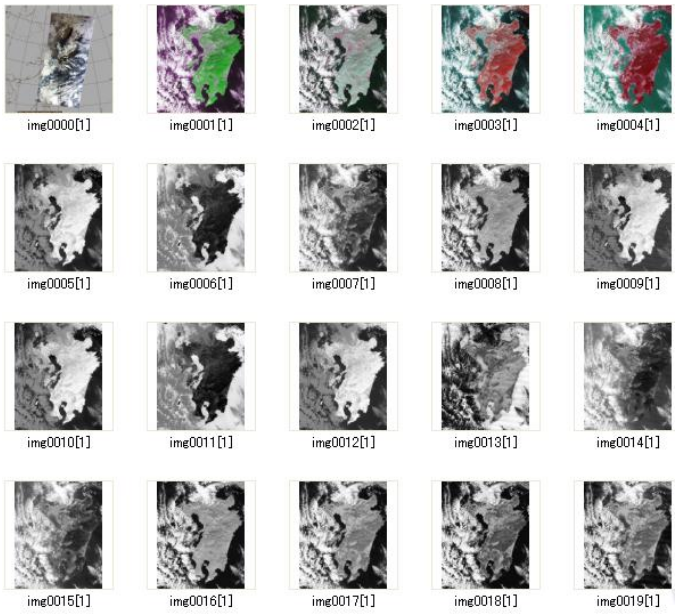


Figure 4. Examples of MODIS data and MODIS derived disaster relieved data

Fig.5 (a) shows the transmitting file size, the data size which has to be transmitted, and transmission rate during the ftp transmission of MODIS data without SkyX. The horizontal axis shows the different types of MODIS data. Meanwhile, Fig.5 (b) shows the file size, the data size, and the transmission rate during the ftp transmission of MODIS data with SkyX. In comparison between Fig.5 (a) and (b), the transmitting file size for both is quite different. The transmitting file size is followed by the data size which has to be transmitted in the case of with SkyX. On the other hand, Fig.5 (c) shows those of data transmission performances together with the number of packet losses in the UDP protocol of data transmission. In the data transmission through UDP protocol, the transmitting file size does not follows the data size which has to be transmitted due to loss of packet.

E. Internet Connectivity

Internet connectivity is checked with the configuration shown in Fig.6. Trace rout command is delivered to Yahoo homepage in the Internet from Saga University to Kyushu University through WINDS satellite. Fig.7 shows trace route window display when Saga University access to the Yahoo home page.

F. Influence Due to Rainfall Attenuations

Influence due to rainfall on data transmission with Ka band[10] of WINDS satellite frequency channel is confirmed. There are two chances of rainfall, August 22 2010 and August 28 2010 during our two weeks experiment as shown in Table 3.

TABLE 3. RAINFALL RATE ON 22 AND 28 AUGUST 2010.

8/22 Kyushu university	around 8:40	Rmax=8.0mm
Saga university	around 12:00	Rmax=13.5mm
8/28 Kyushu university	7:50-10:50	Rmax=0.5mm
Saga university	11:00-12:00	Rmax=0.5mm

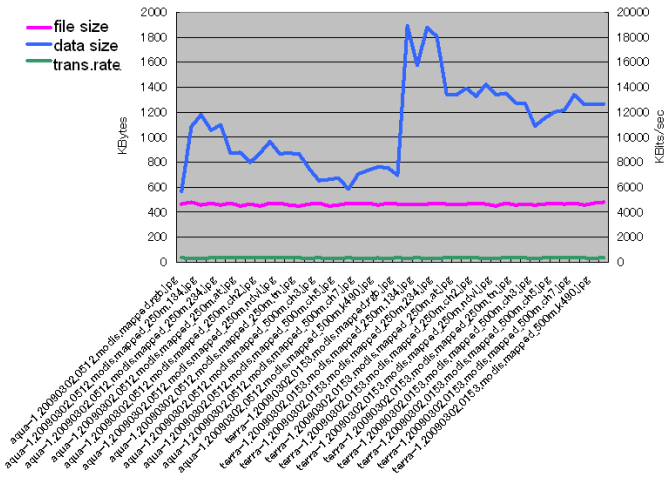
The most severe case (received signal is getting down to -75db and C/No[11] is also getting down to 81db) is occurred at Saga University on around noon on August 22 2009. Fig.8 shows the attenuation due to rainfall which was observed at Saga University on 22 August 2010.

Rainfall influence compensator is equipped in WINDS satellite. Sending power would be better to suppress for consideration of affection to the others (C/No has to be up to 95 dB). The most preferable compensation factor has to be calculated in advance. This can be done through experiments under rainfall

G. Software Accelerator

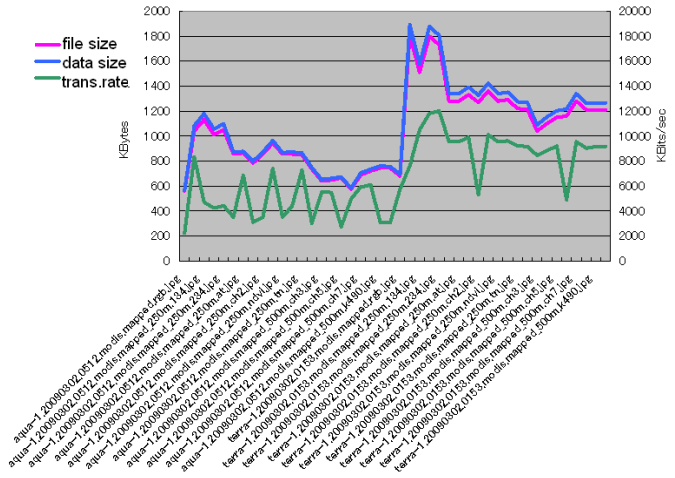
Network accelerator is developed with (1) a shortened acknowledge process, (2) maximum buffer size information transfer.

(1) The required time for transferring acknowledge is shortened. Actually acknowledge is returned immediately after against TCP packet. After that data packers are transferred to the receiver with the other protocol. Although the time required for acknowledge transfer is almost zero of delay time, data packets have to be sent to the receiver after all.

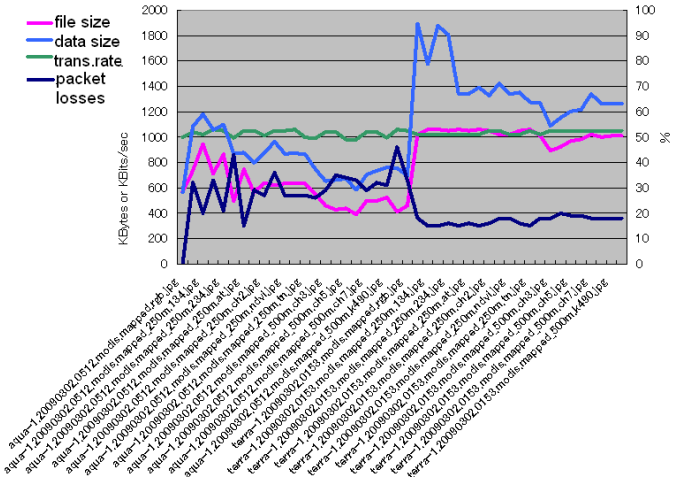


(a) TCP/IP protocol of data transmission without SkyX

[10] http://www.tech-faq.com/ka-band.html
[11] Carrier noise ratio



(b) TCP/IP data transmission with SkyX



(c)UDP data transmission

Figure 5. Data transmission performance through TCP/IP protocol with and with SkyX as well as UDP protocol

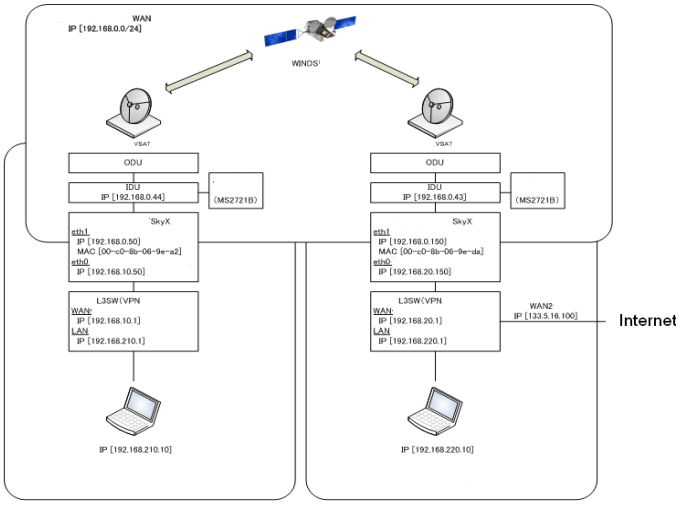


Figure 6. Configuration of internet connectivity

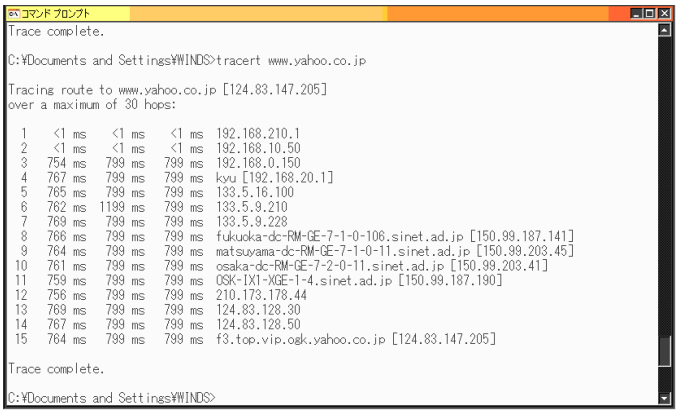
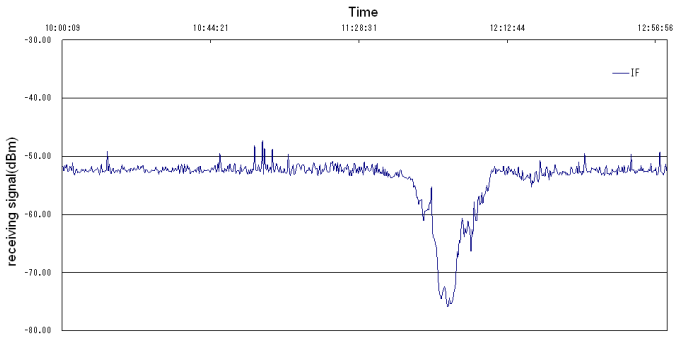
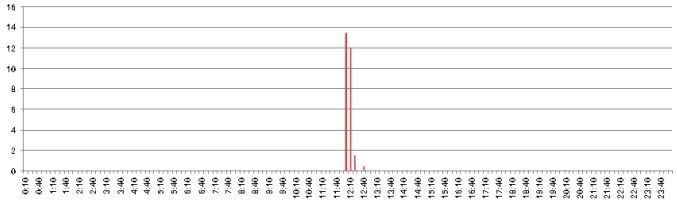


Figure 7. The result of the trace route command when Saga University access to the Yahoo home page through WINDS satellite.



(a) Receiving signal from WINDS satellite to Saga University on August 22 2009.



(b) Coincidence between dip of receiving signal and rainfall at Saga

Figure 8. Attenuation due to rainfall which was observed at Saga University on 22 August 2010.

(2) TCP automatic window size tuning based on RFC 1323[12] and Windows VISTA are to adjust the buffer size of the receiver. Windows VISTA also adjust the buffer size of transmitter. Although the receiver's buffer size is known, data amount which has not received yet by the application software is unknown. During the delay time of 0.8 seconds for satellite communications, most of data are not finished to process if the current PC capability is taken into account. Namely, actual buffer size considering the PC capability and application software processing speed is not transferred to the transmitter and the receiver. Therefore, software acceleration is attempt to replace the buffer size of receiver to the maximum receivable buffer size.

[12] Request for Comments

Fig.9 shows the software accelerator control panel. With this panel, all the buffer size can be monitored and all the operation modes and parameters are selected.

Fig.10 shows Microsoft Network Monitor 3.3[13] utilized packet monitor free software. Using this software, all the packet on the Local Area Network is monitored together with network performance evaluation. It can be monitored the flags of SYN and FIN on the TCP segment which are corresponding to the ftp connection and disconnection with the packet monitor software. Then the time required for transmission is evaluated. Actually, the time required for data transmission evaluated with the packet monitor software is shorter than that of the required time which measured on the DOS windows. Therefore, the additional time is taken into account for getting close to the actual required time.

Experiment on software accelerator is conducted between Saga University and Kyushu University with up-link data rate of 51 Mbps on 27 August. The experimental results are as follows,

(1) Acknowledge process, Maximum window size is transfer, data used: WindsTestSmall.dat(1079064Byte): required time is 1.426757sec

(2) Acknowledge process, without transfer the maximum window size, data used: WindsTestSmall.dat(1079064Byte): required time is 1.426757sec

(3) Without acknowledge process, without transfer the maximum window size, data used: WindsTestSmall.dat(1079064Byte): required time is 367.4569725sec

(4) Acknowledge process, Maximum window size is transfer, data used: WindsTest.dat(310677846Byte): required time is 64.688477sec

(5) SkyX, data used: WindsTestSmall.dat(1079064Byte): required time is 1.08sec

(6) SkyX, data used: WindsTestl.dat(310677846Byte): required time is 75.94sec

Consequently, the proposed software does work as SkyX. SkyX converts TCP protocol to XTP: Xpress Transport Protocol[14]. The proposed software accelerator has almost same functionality as SkyX, XTP protocol specification does not clear though.

III. CONCLUSION

As the experimental results, it is found that

(1) Antennas for communication to the internet satellite, WINDS can be set-up within a 10minutes,

Figure 9. Software accelerator control panel

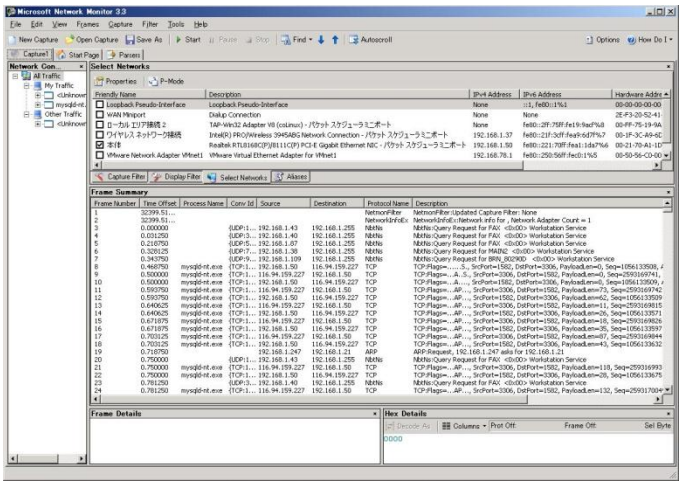


Figure 10. Microsoft Network Monitor 3.3 utilized packet monitor free software.

(2) Network accelerator shows an enough performance for transmission of disaster relief data of MODIS satellite data and moving pictures of disaster relief,

(3) Also acceleration of transmission of disaster information from the residents to local government and evacuation information from local government to the residents

(4) Software accelerator functions are confirmed. It does work effectively and is almost similar effectiveness of the hardware accelerator.

ACKNOWLEDGMENT

The author would like to thank to Prof.Dr.Kiyotaka Fujisaki pf Kyushu University and Mr.Miyahara and Miyauchi of ELM Co.Ltd. for their great effort to conduct the experiments.

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Kohei Arai received a PhD from Nihon University in 1982. He was subsequently appointed to the University of Tokyo, CCRS, and the Japan Aerospace Exploration Agency. He was appointed professor at Saga University in 1990. He is also an adjunct professor at the University of Arizona and is Vice Chairman of ICSU/COSPAR Commission A.