EXPERIMENTS OF THE SPACE WEATHER NETWORK USING JGN2

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ABSTRACT

The National Institute of Information and Communications Technology (NICT) operates a Japanese space forecast center for the International Space Environment Service (ISES). Information on space weather is exchanged daily among the space weather forecast centers all over the world. Researches of space weather need data on large areas of space from the Sun to the Earth's upper atmosphere. It is necessary for researchers of space weather to access various data and to communicate among various other researchers using a network. We describe experiments on the space weather network using the Japan Gigabit Network 2 (JGN2) operated by the NICT.

Keywords: Space Weather, International Space Environment Service (ISES), Japan Gigabit Network 2 (JGN2)

1 INTRODUCTION

The National Institute of Information and Communications Technology (NICT) has operated the Japan Gigabit Network 2 (JGN2), an open test bed network, since April 2004 (Ueno, 2005; Oie, 2005). The JGN2 is a new high-speed network for the research and development of network-related technologies for the next generation and for network application technologies. The JGN2 provides a nationwide network and the link between Japan and the U.S. We have used this JGN2 and constructed a space weather network linking six institutions related to space weather study (Watari et al., 2005). This network activity is described in this report.

2 SPACE WEATHER

Space Weather is defined as the conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can endanger human life and health by influencing the performance and reliability of space-borne and ground-based technological systems (Wright et al., 1995). For example, space storms can cause disruption of satellite operations, communications, navigation, and electric power grids. The NICT (formerly the Communications Research Laboratory) has been conducting a space weather research project in Japan since 1988 (Marubashi, 1989). Similar projects started in 1995 in the U.S. and in 1998 in Europe by the ESA. A space weather study is being carried out as part of an international research project, the Climate and Weather of the Sun-Earth System (CAWSES), by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP).

The International Space Environment Service (ISES) is an international organization concerned with space weather. Eleven countries (Australia, Belgium, Canada, China, the Czech Republic, India, Japan, Poland, Russia, Sweden, and the U.S.) are part of the ISES and operate space weather forecast centers. The NICT operates the Japanese ISES space weather forecast center. Our center makes a forecast everyday and delivers it via our web page (see Figure 1, http://swc.nict.go.jp/contents/index_e.php), e-mail, RSS, and other means.

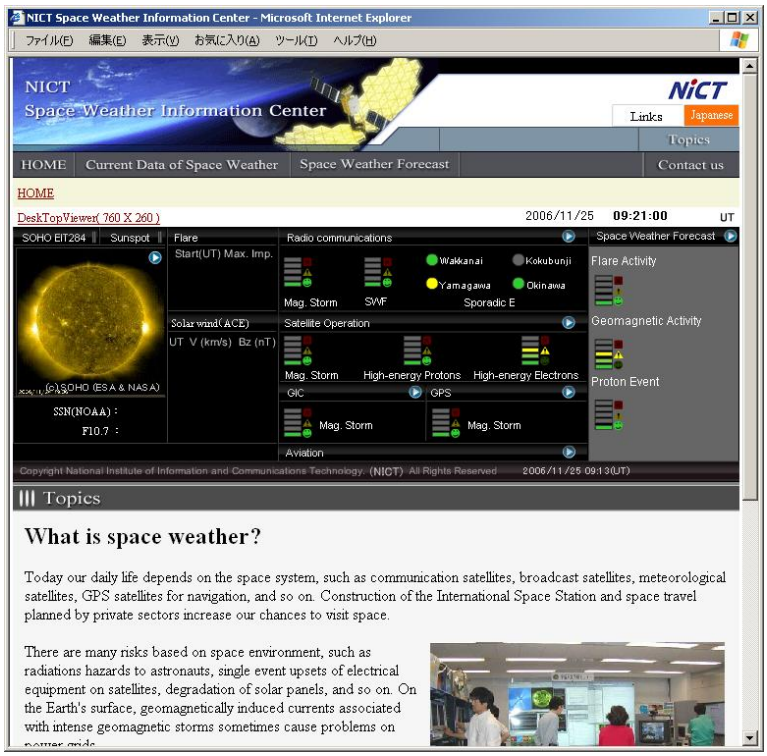

Figure 1. Web page (http://swc.nict.go.jp/contents/index_e.php) of space weather information.

3 EXPERIMENTS USING JGN2

Figure 2 shows the institutions that participate in the experiments on the space weather network using the JGN2. Currently, six institutions are linked to the JGN2 for experiments: the Solar-Terrestrial Environment Laboratory of Nagoya University, the Data Analysis Center for Geomagnetism and Space Magnetism of Kyoto University, the Center for Information Technology of Ehime University, the Space Environment Research Center of Kyushu University, the Yamanashi Prefecture Science Center, and the NICT. A space weather study covers a vast area from the Sun to the Earth's upper atmosphere (the Sun, solar wind, magnetosphere, ionosphere, and thermosphere). A key element of this study is to enable a seamless exchange of information and data among all the researchers involved. We have constructed a space weather network that links the institutions involved in the space weather study and have conducted tele-workshops on solar-terrestrial data analysis, conducted tele-lectures on space weather for outreach, shared the results of space weather simulations, and engaged in other important work.

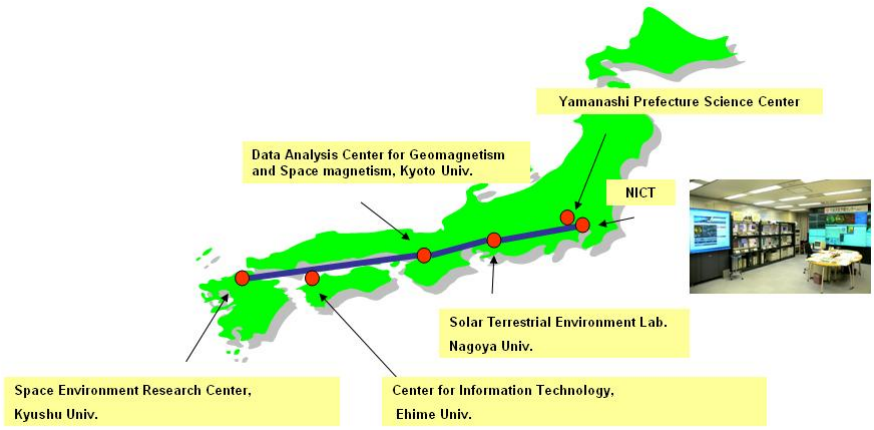

Figure 2. Institutions of the space weather network.

We experimented with sharing the results of a real-time simulation among distributed researchers in the Super Computing Conference 2005 (SC|05) in Seattle, Washington, U.S.. A three-dimensional magneto hydro-dynamic (MHD) simulation code of the Earth's magnetosphere was developed by Tanaka (1994). This simulation runs routinely with a small mesh size (44x56x60) at the NICT (Den et al., 2006a; Den et al., 2006b) and provides the conditions of the Earth's magnetosphere in a near real-time manner. The simulation's input is the real-time solar wind data from the ACE spacecraft. This spacecraft sits in the Lagrange point 1 (L1), where the gravity of the Sun and the Earth are in balance. The L1 is approximately one-hour upstream of the Earth based on typical solar wind speed. As a result, we can obtain the conditions of the magnetosphere approximately one hour after this simulation.

For a demonstration of the SC|05, the results of a real-time simulation were visualized in the NICT, and the visualized data was send to an exhibition booth in Seattle using the network of the JGN2 that connects Japan and the U.S. Figure 3 shows the SC|05 exhibition booth. In this experiment, we demonstrated that we can simultaneously share the results of a real-time space weather simulation between the NICT and Seattle. Currently, we are conducting a simulation with a small mesh size because of limited computing power. An increase in computing power from progressive technology will enable us to complete a simulation with a larger mesh size in near real time. A high-speed network will enable us to exchange the massive data produced by the simulation.

Figure 3. Exhibition booth in SC|05.

4 SUMMARY

The Electronic Geophysical Year (eGY) is planned for 2007-2008 as the 50th anniversary of the International Geophysical Year (IGY), which took place in 1957-1958. The IGY encouraged scientists to create world-wide ground based observation networks on solar terrestrial environment and data centers to deliver data. Information technology has made huge advances since the IGY era. A great improvement in data accessibility should occur during the eGY era because of the advancements made in information technology. Our research will be a part of this new era.

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