

RESEARCH ENVIRONMENT AND INFORMATION SERVICE OF THE SPACE WEATHER CLOUD

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ABSTRACT

To optimize space weather research and information services, it is important to establish a comprehensive system that enables us to analyze observation and simulation data in an integrated manner. For this, we recently constructed a new computing environment called the “Space Weather Cloud Computing System” of the National Institute of Information and Communications Technology (NICT). Currently, the Space Weather Cloud contains a high performance computer, a distributed mass storage system using the Grid Data Farm (Gfarm) technology, servers for analysis and visualization of data, a job service based on the RCM (R&D Chain Management) system, servers for Solar-Terrestrial data Analysis, and the Reference System (STARS).

Keywords: Space weather, Cloud computing system, Gfarm, JGN-X, STARS

1 INTRODUCTION

Space weather is the concept of changing environmental conditions in the space between the Sun's atmosphere and the Earth's atmosphere. Space weather variations affect human-made infrastructures such as artificial satellites, electric power grids, the Global Navigation Satellite System (GNSS), and HF radio communication (Marubashi, 1998; Lanzerotti, 2001). It is difficult to cover the whole of this vast space using only the existing observational framework. We need a new environment to analyze both the observation data and simulation data in an integrated manner (Baker & Barton, 2008; Rankin, 2011). Added to this, the amount of data on space weather has been increasing year by year because of a remarkable increase in new data from ground-based observations, observations using spacecraft, and simulation models. We need a computing environment that can process these big data. In order to cope with this situation, a new platform called the ‘Space Weather Cloud Computing System’ (hereafter Space Weather Cloud) has been constructed in the National Institute of Information and Communications Technology (NICT). We report details of this system and show examples of its applications.

2 OUTLINE OF THE SPACE WEATHER CLOUD COMPUTING SYSTEM

Figure 1 shows the general concept of NICT's ‘Space Weather Cloud’. The system is composed of a super computer, a distributed mass storage system based on the Grid Data Farm (Gfarm) technology (Tatebe et al., 2001), servers for analysis and visualization of data using IDL (Interactive Data Language) and AVS (Advanced Visual Systems), a job service component based on the R&D Chain Management (RCM) system, a tool for data plotting and analysis called the Solar-Terrestrial data Analysis and Reference System (STARS), servers to automatically collect metadata (NICTY), streaming servers, Tiled Display Wall (TDW), etc. The Space Weather Cloud can be accessed via networks such as the Internet and the New Generation Network Testbed (JGN-X, <http://www.jgn.nict.go.jp/english/index.html>), which is a new generation network developed by NICT.

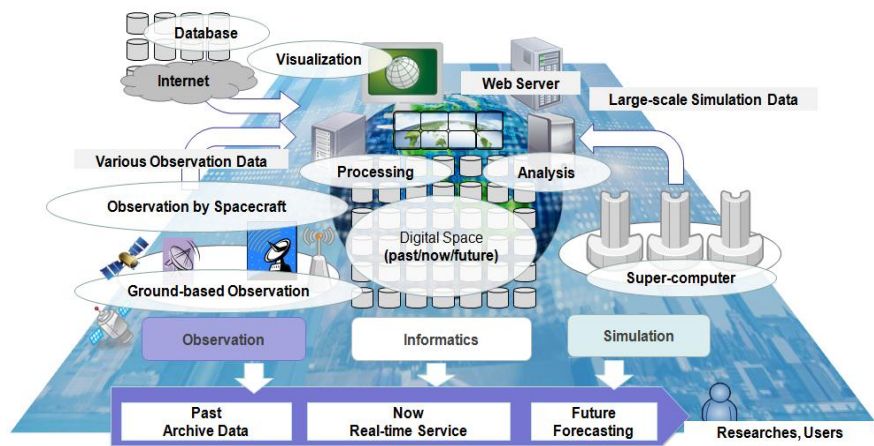


Figure 1. A conceptual diagram of NICT's Space Weather Cloud

3 INFORMATION SERVICES OF THE SPACE WEATHER CLOUD COMPUTING SYSTEM

The Space Weather Cloud provides various Web-based services for general users. Figure 2 shows our e-SW Web page (<http://e-sw.nict.go.jp/>), which is the portal of the Space Weather Cloud information services. Several examples of Space Weather Cloud services are shown in the following sections. Much of the contents is explained in both Japanese and English. We will increase the English content of our services in the near future.



Figure 2. The e-SW Web page, which is the entrance to Space Weather Cloud services

3.1 Space weather board

The space weather board, shown in Figure 3, is a tool to enable users to customize space weather data. There is a variety of space weather users, such as satellite operators, users of the Global Navigation Satellite System (GNSS), and operators of HF communication. This board will allow these users to customize the display of plots and images on the screen, according to their individual purposes. By using this board, users can select data sets from the component list and arrange them as they want. Then users can store their own arrangements in the server for their convenience.

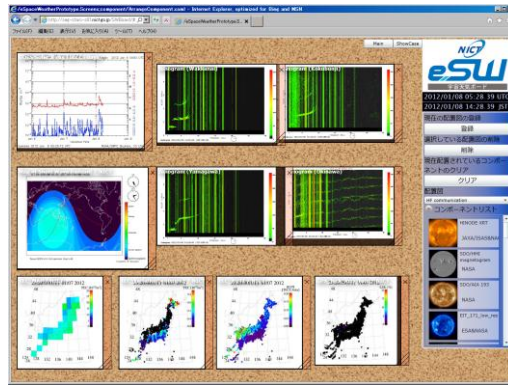


Figure 3. An example of the Space Weather Board Web page (customized to show ionospheric data)

3.2 3D View of a real-time space weather simulation

NICT has developed magneto-hydrodynamic simulation codes covering the region from the solar corona to the terrestrial ionosphere (Nakamizo et al, 2009; Den et al., 2006; Shinagawa, 2011). We run the simulation in a real-time basis. The results of the simulations are sorted and displayed by the Space Weather Cloud's 3D-visualization system. Users can access real-time and archived data through the 3D view Web page.

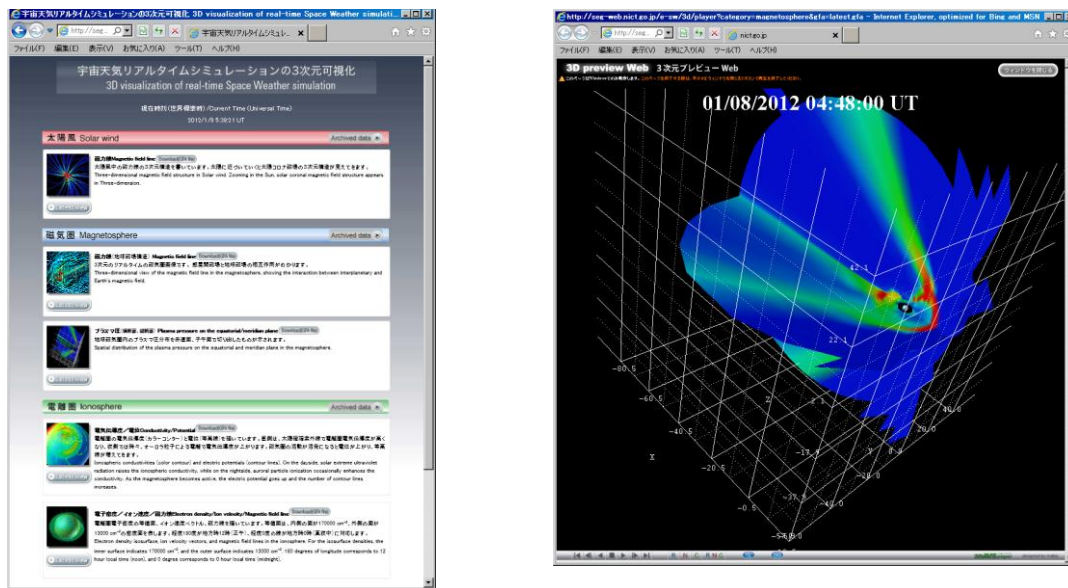


Figure 4. The Web-page of 3D view of real-time space weather simulation (left panel) and an example of the 3D view of the terrestrial magnetosphere (right panel)

3.3 Weekly Space Weather News

The concepts and terminology of space weather are unfamiliar to the general public. To improve this situation, we have started a video program giving a weekly summary of current conditions of the space weather, under the name 'Weekly Space Weather News'. It is delivered by streaming from the Space Weather Cloud server. Brief explanations of technical terms of space weather are also provided to help with understanding the contents. Examples of scenes from the program are shown in Figure 5.



(a) Opening of the 'Weekly Space Weather News'



(b) Outline of the week's space weather



(c) Detailed information of the week's space weather



(d) Explanation of space weather terminologies

Figure 5. Scenes from the 'Weekly Space Weather News'

4 SUMMARY

The data volume of space weather is increasing year by year. New data is coming from satellites, ground-based observational networks, numerical simulations, etc. It is urgent to construct a computing platform to efficiently process both observation and simulation data together (Baker & Barton, 2008; Hey et al., 2009; Rankin, 2011). Our cloud computing system will be an example to meet this demand, and it is expected that new knowledge about space weather will be extracted from our data intensive studies using the Space Weather Cloud.

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