

Current implementation status of WISE-CAPS, browsing, sharing and analyzing system of lunar and planetary data

TERAZONO, Junya^{1*}, NAKAMURA, Ryosuke², Shinsuke Kodama², Naotaka Yamamoto², DEMURA, Hirohide¹, HIRATA, Naru¹, OGAWA, Yoshiko¹, Tomoetsu Sugawara¹

¹The University of Aizu, ²The Institute of Advanced Industrial Science and Technology

We are now developing data browsing, sharing and analyzing platform for lunar and planetary exploration data. This system is called "WISE-CAPS",

Web-based Integrated Secure Environment for Collaborative Analysis of Planetary Science.

The WISE-CAPS aims for efficient analysis of vast amount of data obtained by lunar and planetary exploration, particularly one for image data, and sharing among registered researchers. The final processing, analyzing the data, is our goal for this implementation.

System is fully web-based, Web-GIS, therefore users do not need to prepare any special software other than browser to use WISE-CAPS. The base of system is map (image based) and it is also the reason that this system is entirely based on maps. However, WISE-CAPS has several unique functions such as data addition by users (uploading of data which are created by users) and its sharing to other users, including selection of users. Furthermore, as this system is constructed fully upon open-source software and is open platform and protocol compliant, the linkage with other systems and vendor-independent re-construction, modification and enhancement can be made easily with low budget. Extension of functions by users are in our sight for future implementation.

We have made large improvements for WISE-CAPS since last year and now the

system has become more user-friendly and powerful. We will address the improvement points and future directions for more improvement.

Keywords: Web-GIS, lunar exploration, planetary exploration, web

New version of Zindaiji, a GUI visualization tool for large number particle simulation data.

TAKEDA, Takaaki^{1*}

¹National Astronomical Observatory of Japan

Visualization of 3D/4D simulation data is important not only for research but also for public outreach.

The tools of scientific visualization are often designed for the former purpose. However, for outreach purpose, these tools have often difficulties, because they often lack the functions such as camera work editing or drawing modelled objects, texturing, etc. On the other hand, using general purpose 3DCG softwares, it is easier to visualize objects with higher quality. However, converting data to the format which can be read by these softwares requires skills of computer graphics, and researchers do not have it in general.

We have developed a GUI application (Zindaiji) to visualize particle data, several years ago. In NAOJ 4D2U Project, we have made high quality movies for public outreach, with up to 2 million particle N-body simulation data. However, Zindaiji is developed as 32bit windows application, so that it can not handle recent larger scale N-body simulation data.

Thus, we are now developing new versions of Zindaiji as 64bit applications, and basic functions have now been implemented. The features of Zindaiji are,

- 1)Ability to make movies from sequential particle data.
- 2)Implementation of interpolation of data.
- 3)Fast rendering using OpenGL.
- 4)GUI based, and time-line based interface.

In Zindaiji 3, we have improved following features.

- 5)Making as 64-bit application, memory limitation is much alleviated.
- 6)Great improvement in operability.
- 7)Improvement in the rendering speed by reexamination of a drawing algorithm.
- 8)Reduction of waiting time by multithread-izing and data prefetch.
- 9)Multi-platform (Windows/LINUX/MacOSX)

On the now, Zindaiji3 is not implemented with the features such as motion blur or lens flare (which are implemented in Zindaiji). We will add these features to Zindaiji 3 as the future works.

The binary and source code is published to the web.

http://th.nao.ac.jp/~takedatk/COMPUTER/ZINDAIJI3/Zindaiji3Top_E.html

Keywords: Visualization, N-body simulation

Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project

HORI, Tomoaki^{1*}, HAYASHI, Hiroo², KOYAMA, Yukinobu³, TANAKA, Yoshimasa⁴, SHINBORI, Atsuki², ABE, Shuji⁵, UENO, Satoru⁶, YONEDA, Mizuki⁷, KANEDA, Naoki⁶, UMEMURA, Norio¹, KONO, Takahisa⁸, YOSHIDA, Daiki⁹, KAGITANI, Masato¹⁰, TADOKORO, Hiroyasu⁷, MOTOKA, Tetsuo⁴

¹STE lab., Nagoya Univ., ²RISH, Kyoto Univ., ³WDC for Geomag, Kyoto, Kyoto Univ., ⁴NIPR, ⁵SERC, Kyushu Univ., ⁶Kwasan and Hida Obs, Kyoto Univ., ⁷Dep. Of Geophys., Tohoku Univ., ⁸Institute for Solid State Physics, The University of Tokyo, ⁹Weather Information & Communications Service LTD., ¹⁰PPARC, Tohoku Univ.

The Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project (2009-2014) is an inter-university program by the National Institute of Polar Research (NIPR), Tohoku University, Nagoya University, Kyoto University, and Kyushu University to build a database of metadata (data of data such as observation period, type of instrument, location of data, and so on) for ground-based observations of the upper atmosphere since the IGY in 1950s. The IUGONET metadata database (MDDB), which archives the information on a variety of observations by radars, magnetometers, optical sensors, helioscopes, etc. in different locations all over the world and in various altitude layers from the troposphere up to the heliosphere, will be of great help to researchers in efficiently finding and obtaining observational data they need. This should also facilitate synthetic analyses of multi-disciplinary data, leading to new types of research in the upper atmosphere. Last year we finally released the MDDB which we had developed by modifying a repository software DSpace as well as the integrated data analysis software called UDAS based on the THEMIS Data Analysis Software (TDAS) written in IDL. Both of them are freely available to all researchers. The IUGONET project is just starting its fourth year, that is, the first year of the latter half of the six-year project. We continue to add newly-coming metadata to our MDDB so that it provides more extensive coverage for the data search. Our effort is also made to have more IUGONET data supported by UDAS and to develop new functions for data processing/visualization on the UDAS platform. The achievements of the project for the first three years with some scientific results as well as the road map for the latter half of the project period are presented in the talk.

Keywords: upper atmosphere, metadata, repository, ground observation, database

An ambitious challenge of "science cloud" in NICT

MURATA, Ken T.^{1*}, WATARI, Shinichi¹, NAGATSUMA, Tsutomu¹, WATANABE, Hidenobu¹, KUNITAKE, Manabu¹, YAMAMOTO, Kazunori¹, MURANAGA, Kazuya², MURAYAMA, Yasuhiro¹

¹NICT, ²SEC Co.,LTD.

Main methodologies of Solar-Terrestrial Physics (STP) so far are theoretical, experimental and observational, and computer simulation approaches. Recently "informatics" is expected as a new (fourth) approach to the STP studies is a methodology to analyze large-scale data (observation data and computer simulation data) to obtain new findings using a variety of data processing techniques.

The first approach, theory, does not require any infrastructure. Maybe, pen and paper would be enough. In the STP fields, the infrastructure for observations is observatory and satellite. For simulations, the infrastructure is, of course, super-computer. What is the infrastructure for the fourth methodology? The answer is cloud. The cloud computing environments should play significant roles in science and technology. However, a variety of clouds have been used mainly for business fields, and

At NICT (National Institute of Information and Communications Technology) we are now developing a new research environment named OneSpaceNet. The OneSpaceNet is a cloud-computing environment, which connects many researchers with high-speed network (JGN: Japan Gigabit Network). It also provides the researchers with rich computational resources for research studies, such as super-computer, large-scale storage (disk) area, data processing parallel cluster workstations with GPGPUs, licensed applications, DB (database) and meta-DB, and communication devices. What is amazing is that a user simply prepares a terminal (low-cost PC) to make use of the resources. After connecting the PC to JGN, the user can make full use of the rich resources via L2 network. Using communication devices, such as video-conference system, streaming and reflector servers, and media-players, the users on the OneSpaceNet can make research communications as if they belong to a same (one) laboratory: they are members of a virtual laboratory.

We present two initial results using the OneSpaceNet for large-scale computer simulation data transfer and virtual observation data transfer system.

Keywords: Big Data, Science Cloud, OneSpaceNet

Visualization for Oceanic General Circulation Model via Multivariate Analysis

MATSUOKA, Daisuke^{1*}, ARAKI, Fumiaki¹, KIDA, Shinichiro¹, SASAKI, Hideharu¹, Bunmei Taguchi¹

¹Earth Simulator Center, JAMSTEC

Visualization of numerical simulation data is necessary to understand intuitively natural phenomena or structures. However, it is difficult to extract informative data from large scale datasets that is output from large scale high resolution simulation on the massively parallel supercomputer.

We, then, research the feature extraction method and generation method of transfer function to obtain effective visualization results from high-resolution numerical simulation. In this work, the feature extraction methods from the ocean general circulation model (OFES) data and the visualization methods which emphasis the feature are development. The features such as ocean currents, vortices or water masses are extracted by using a multivariate analysis which clustering from temperature, salinity, fluid velocity and etc. Good visualization results with emphasis features can be made by using these extracted features.

In this presentation, we will report the application examples to visualize the currents of the Kuroshio / Kuroshio Extension region and the water mass of the thermohaline circulation.

Keywords: OGCM, visualization, multivariate analysis, cluster analysis, transfer function

Development of ASTER Hot Spot Detection System using International Standards

YAMAMOTO, Naotaka^{1*}, NAKAMURA, Ryosuke¹, TSUCHIDA, Satoshi¹, IWAO, Koki¹, URAI, Minoru¹

¹AIST

In this presentation, we propose a new design of ground data management system for earth observing satellite data archive, in order to achieve an alert system development for volcanic activities, forest fire, environment monitoring, etc. There are some major activities, such as MODIS Rapid Response. However, these systems are usually maintained by organizations who have a ground data management system. Therefore, it is hard to construct such a rapid monitoring system by research groups outside of a ground data management system. In order to solve this inconvenience, we propose a design of ground data management system using international standards such as GeoRSS, WMS, WCS and WPS. In addition, we present an ASTER hot spot detection system using international standards as an example implementation.

Keywords: ASTER, GeoRSS, OGC

Provision of map data through Digital Japan Web System

KANDA, Hirofumi^{1*}, SATO, Hiroshi P¹, SATO, Takenori¹, Yukiko Tachibana¹, Yutaka Kosuge¹

¹GSI of Japan

The use of GIS is changing over time. Purchasing desk-top GIS was common method to view map images and to superimpose geospatial data on them; however, Web-GIS usage has been popular. In this presentation we explain about Digital Japan Web System and mention the Ver.3 (Sato et al., 2011) that uses open source software, published in December, 2011.

Reference

Sato T, Iita G, Tachibana Y, Syudo T, Sato HP, 2011, Development of Digital Japan Web System open source version. Proceedings of 2011 Meeting on GIS Association of Japan, F-7-2.

Keywords: Web, GIS, Map, Digital Japan Basic Map (Map Information)

Integration of Public Borehole Information Databases in Kanto Region

OOI, Masahiro^{1*}, KIMURA, Katsumi², YOKOKURA, Takanobu², KOU, yoshihide², FUJIWARA, Hiroyuki¹

¹National Research Institute for Earth Science and Disaster Prevention, ²National Institute of Advanced Industrial Science and Technology

In the Kanto region, some local governments, such as the prefectures of Tokyo, Gunma, Tochigi and Kanagawa and the City of Kawasaki, share their borehole data on the Internet.

It is convenient for users if they are not only able to view underground structure data, registered in the portal site, and public borehole data of other organization, posted on the Internet, displayed concurrently on the map but also allowed to browse borehole data held by other organizations through portal site access. This can be beneficial for data providers as well.

To link with borehole data of local governments posted on the Internet, a function that registers metadata, such as borehole data location and total excavation length, is added to the portal site. This allows URLs of public borehole data to be associated.

Keywords: underground structure, database, borehole data, geophysical exploration, metadata, portal site

A visualization tool for Yin-Yang grid data and virtual reality visualization of frozen-in vector fields

YOSHIDA, Masato¹, MURATA, Kaori¹, KAGEYAMA, Akira^{1*}

¹Graduate School of System Informatics, Kobe University

We have developed the following two visualization tools and methods. Details will be reported in the talk.

(1)

We have developed an interactive visualization software, "SV4" for Joint Project for Space Weather Modeling (JPSWM) project. One of characteristic features of SV4 is that it visualizes data defined on a spherical grid system named Yin-Yang grid. Although SV4 is developed as a part of JPSWM project, it can be used in other projects that make use of Yin-Yang grid. Since Yin-Yang grid is now widely used in various fields in geophysics and astrophysics, SV4 would be useful for them, too. Another characteristic feature of SV4 as a visualization software is its base programming language. SV4 is coded in Fortran90 with a graphics library f90gl which is a Fortran interface for OpenGL and GLUT. Having found that most researchers involving JPSWM project use Fortran90/95 and they are not familiar with C/C++, which are standard languages used in computer graphics, we have decided to develop a fully Fortran-based visualization tool and provide the source codes in order that the simulation researchers can customize them. SV4 displays magnetic field lines with their releasing points from which magnetic field lines are integrated. The user can control a releasing point by the mouse drag. The magnetic field line is calculated in real time and shown on the screen. SV4 can visualize scalar fields by the isosurface method. The isosurface level is interactively controlled by the mouse drag. One can rotate, translate, and zoom in/out the visualized 3-dimensional objects in the display window. Another visualization method for scalar data implemented in SV4 is the ortho-slicer in which distribution of the scalar is shown by color contours on x-y, y-z, and z-x planes.

(2)

To analyze three-dimensional data of computational fluid dynamics and magnetohydrodynamics (MHD), a new visualization method based on virtual reality (VR) technology is developed. In this method, a "tracer line" is transported or advected by the target flow in three-dimensional VR space. Observing its deformation process, one can intuitively understand the flow's structure, especially the stretching and twisting components. Since a tracer line is identical to a line of force of a vector field that is frozen-into the flow, the VR tracer line method proposed in this study can also be regarded as a new visualization method for the frozen-in vector field such as magnetic field in the ideal MHD or vorticity field in the Euler fluid. A program named TubeAdvect is developed for the implementation of the VR tracer line method. In TubeAdvect, its initial condition or the initial curve of a tracer line is intuitively specified by moving a portable controller or a 3D mouse in the VR space. The initial curve is then released to be advected by the target flow to be analyzed. When a distance between a pair of consecutive points becomes larger than a pre-defined length, a new point is inserted between them. Since the stretching and twisting components of the flow are key features of the magnetic field generation process in the MHD, the VR tracer line method is useful to analyze geodynamo or solar dynamo simulations. A problem of the VR tracer line method is that it does not convey local flow information around the curve. To resolve this problem, wheel-like objects are added to the tracer line. Radial change of a ring in each wheel shows the divergence component of the flow away from the tracer line at that position. Local colors of the tracer line and their temporal change convey stretching rate of the tracer line there. The original TubeAdvect and the improved one named wTubeAdvect are tested on three kinds of analytically defined flows as well as output data of a geodynamo simulation, and the usefulness of the VR tracer line method implemented by TubeAdvect and wTubeAdvect is confirmed.

Keywords: data visualization, Yin-Yang grid, virtual reality

Visualization technique of NICT Science Cloud using large quantities of magnetosphere Global MHD simulation data

KUBOTA, Yasubumi^{1*}, MURATA, Ken T.¹, YAMAMOTO, Kazunori¹, FUKAZAWA, Keiichiro², TSUBOUCHI, Ken³

¹NICT, ²RIIT, Kyushu Univ., ³The University of Tokyo

We will present a new visualization technique by using large quantities of simulation data. The time development of 3D object with high temporal resolution provides the opportunity of scientific discovery. We visualize large quantities of simulation data using visualization application 'Virtual Aurora' based on AVS and the parallel distributed processing at 'Space Weather Cloud' in NICT based on the Gfarm technology. We show a visualization of dayside reconnection using a system of magnetic field line tracing in order to understand magnetosphere convection. On the other hand we try to make a computer graphics of magnetosphere dayside reconnection for outreach activities. In this lecture, we introduce our recent visualization for science and outreach activities.

Keywords: Visualization, NICT Science Cloud, Big simulation data, Magnetosphere

Information services and data analysis using space weather cloud

WATARI, Shinichi^{1*}, TSUBOUCHI, Ken², Hisao Kato¹, MURATA, Ken T.¹, YAMAMOTO, Kazunori¹, Hidenobu Watanabe¹, KUBOTA, Yasubumi¹, KUNITAKE, Manabu¹

¹National Institute of Information and Communications Technology, ²University of Tokyo

It is called space weather that variation of space environment affects on artificial satellites, power grids, Global Navigation Satellite System (GNSS), and so on. It is difficult to cover only for observations to cover vast domain from the Sun to the Earth. Therefore, we need a computing environment where observation data and simulation data can be analyzed together. Moreover, amount of data which we need to handle has increased every year. To resolve those situation, National Institute of Information and Communications Technology (NICT) has developed "Space Weather Cloud computing system" which consists of a supercomputer, large storage system based on Grid Data Farm (Gfarm) technology. There are several information services using Space Weather Cloud. A web application called "Space Weather Board" enables users to make their customized data arrangement. Three-dimensional visualization of result of real-time space weather simulation is provided from a web server in the Space Weather Cloud. A movie program on weekly summary of space weather called "Weekly Space Weather News" is provided by a streaming server of the Space Weather Cloud. We will also report an example of analysis of the real-time simulation data of Earth magnetosphere and observation data using the Space Weather Cloud.

Keywords: cloud computing system, space weather, informatics

A Virtual Observation Network System for Global Ground-Based Observatories

WATANABE, Hidenobu^{1*}, YAMAMOTO, Kazunori¹, MURATA, Ken T.¹, WATARI, Shinichi¹, NAGATSUMA, Tsutomu¹, ISHIBASHI, Hiromitsu¹, KUNITAKE, Manabu¹, TSUGAWA, Takuya¹, OKADA, Masaki²

¹NICT, ²NIPR

As our ground-based global observation technology develops, the number of the observatory is getting larger. As the number increases, both maintenance of the observatories and data transfer gets harder. Most of such data transfer systems are equipped on the Internet. However, since the QoS of the Internet is not ensured in general, we need to monitor the data transfer manually, and it is one of the reasons of difficulty in operating our global observation systems.

For instance, the number of NICT space weather observatories, domestic and international, is already more than 20 and the sort of the transferred data is more than 40. The condition of the data transfer networks depends on the location of the observatory: we need to collect observation data even from the worst network condition observatory.

In order to unify such data collection networks, we have been developing a virtual observation network system for global ground-based observatories. We also equipped this network system on the small PC server, and deployed over 8 observatories of NICT space weather. The network technology used in the system is not new, but the system so far works continuously and successfully. The collected data are saved and managed in a distributed storage in the OneSpaceNet (a science cloud in NICT).

Herein we discuss the concept and design of the virtual observation network system for global ground-based observatories and demonstrate how it works.

Keywords: Earth Observation, virtual network, cloud computing

Sharing of knowledge for collaborative analysis in the Solar-Terrestrial data Analysis and Reference System [STARS]

KUNITAKE, Manabu^{1*}, YAMAMOTO, Kazunori¹, Kentaro Ukawa², Eizen Kimura³, Hisao Kato¹, NAGATSUMA, Tsutomu¹, WATARI, Shinichi¹, MURAYAMA, Yasuhiro¹, MURATA, Ken T.¹

¹NICT, ²SEC, ³Ehime Univ.

Cross-sectional data analyses have become important for further understandings of Solar-Terrestrial Physics (STP) fields. There are variety types of observation target in STP fields, for example, the sun, solar wind, interplanetary magnetic field, the magnetosphere and the ionosphere of the earth. There are variety types of observation technique, for example, in-situ observations by spacecrafts, remote sensing by spacecrafts, and ground-based observations. It is hard for one researcher to be familiar with all of the observations. Usually, one researcher is a specialist in one or some types of observations and is not a specialist in the other observations. Therefore, cross-sectional data analyses require cooperative works by researchers whose own specialties are different from each other. If the knowledge and the experiences of each researcher are exchanged with each other, these exchanges boost to do collaborative analysis.

The Solar-Terrestrial data Analysis and Reference System (STARS) is a system, which realizes cross-over search and integrated analyses with combined plot of STP fields. The STARS has two special functions for cooperative works. One is Stars Project List (SPL). The other is event list database. Sharing of the SPL is useful for interactive information exchanges between researchers. The event list database provides users of the STARS crossover hints for recognizing typical STP phenomena.

Stars Project List (SPL)

After a user on the STARS downloads several types of data and makes a combined plot, the information about the downloading data and the information about plotting can be stored in an XML file. The XML file is called as Stars Project List (SPL). Because an SPL contains detailed information of a combined plot, not only the user who made the combined plot but also any other users can easily make the same plot without checking data file download options and plotting options. Further, any user can modify the combined plot by adding data file or by changing plotting options.

One of the interactive ways of sharing SPL in the collaborative analysis between researcher A and researcher B is as follows. (1) The researcher A downloads data AA which the researcher A is familiar with. (2) The researcher A makes a plot about data AA and saves SPL#1. (3) The researcher A sends SPL#1 to the researcher B. (4) The researcher B receives SPL#1. (5) The researcher B easily makes the same plot based on the information stored in the SPL#1 and views the plot. (6) The researcher B downloads data BB which the researcher B is familiar with. (7) The researcher B modifies the original plot by adding data BB to the original plot and saves SPL#2. (8) The researcher B sends SPL#2 to the researcher A. (9) These processes are repeated interactively until a final combined plot is completed.

Event list database

When one researcher finds an interesting variation of typical phenomena in the plot, then the researcher recognizes it as an event. The researcher can register the event in the event list database in the STARS. Each event is described in XML. Each XML file contains detailed information (title, start/end time, comment, name who registered the event etc.). When a variety of the researcher register the events based on their own specialties, the event list database becomes rich and covered fields increase. The event list database is, in some sense, 'accumulated knowledge of specialists'.

Any user of the STARS can know the events which have been already registered by other users as well as by oneself by using quick viewing tools. It means that the accumulated knowledge of specialists is 'shared' by all of the STARS users.

In collaborative analysis, event list database provides all participants crossover hints for recognizing typical occurrences of STP phenomena.

Keywords: XML, cross-sectional studies, cooperative work, common use

ERG-Science Center Project: Importance of the integrated data analysis system for multi-kinds of geospace data

MIYOSHI, Yoshizumi^{1*}, SEKI, Kanako¹, HORI, Tomoaki¹, MIYASHITA, Yukinaga¹, SEGAWA, Tomonori¹, TANAKA, Yoshimasa²,
ERG-SC task team¹

¹STEL, Nagoya University, ²NIPR

Recent geospace sciences use multi-kinds of data from satellites, ground, and also simulation data for integrated studies. Although each data covers some limited areas and periods, the analysis by integrating many data sets provides better perspectives of the phenomena and enhances comprehensive understanding. However, the integrated data analysis is not always easy, because the data-handling of different data sets requires tremendous effort and time. The self-describing data files and the integrated data analysis tools are essential for seamless integration for data-sets. Today, the CDF (Common Data Format) developed by NASA/GSFC is a standard data format of space science data, and many CDF files of satellite and ground-based data are archived, which free the researchers from the time-consuming working for data-handling. Moreover, the THEMIS data analysis suite (TDAS) is powerful software to process the CDF files. Users who are not familiar with the data can easily use different kinds of data sets. Considering the recent development of the CDF and TDAS in the space physics community, the ERG Science Center team has been preparing the CDF files of the ERG project data and developing the plug-in tools for the TDAS. Some of the ground magnetometer data, SuperDARN HF radar data, VLF, and CNA data can be analyzed with TDAS. We also develop the web analysis toll (ERG-WAT) that is a web-based quick-look and simple analysis system. In this talk, we report the current status of our activity and demonstrate how the plug-in tool loads and visualizes the ERG-related data.

Keywords: ERG-project, integrated data analysis tool, metadata, geospace science

Study on a new algorithm on similar data retrieval from plasma wave spectrum observed by solar-terrestrial satellites

ZHANG, Fenghua^{1*}, KASAHARA, Yoshiya¹, GOTO, Yoshitaka¹

¹Kanazawa University

In recent years, the total amount of data measured by scientific spacecraft has drastically increased as the resolution of each instrument becomes higher. It is a difficult task to find some interesting phenomena in it. It is necessary to develop a new computation method for automated classification and data analysis. There are two issues to be solved for similar data retrieval. One is to develop a method which can be applied to different types of satellite data, and the other is to increase efficiency of the retrieval method. In this study, we show how to solve these two problems, and we applied our proposed method to the plasma wave data measured by WFC-H, and WFC-L onboard KAGUYA and MCA onboard Akebono for evaluation.

First, in order to reduce the amount of data retrieved, we need to define the characteristic parameters of the data. In general DCT or Wavelet is applied for natural picture to extract the characteristic quantity. In the present study, we applied DCT transform to the spectrogram data and extracted DC and low frequency part of AC components as characteristic quantities. It is noted that the characteristics of spectrogram of the plasma wave measured by solar-terrestrial satellites are different from the ones of natural image data, that is, the transformed components of the spectrogram using DCT are mainly left in the first row and first column.

Faced with a large number of observation data, retrieval using walkthroughs is impossible. In order to improve the efficiency, we adopted multi-dimension index as a solution. The multi-dimensional index is mainly used for similar image retrieval, to reduce computation time for retrieval from large amount of multi-dimensional characteristic parameters. In our study we use the algorithm named SR-Tree, which combines the advantages of the S-Tree and R-Tree. In the presentation, we introduce the way to put SR-Tree in the retrieval of satellite spectrum data.

Keywords: plasma wave, similar data retrieval, database, scientific satellite

Development of a package of correlation analysis and statistical tests for various solar-terrestrial environment data

HAMAGUCHI, Ryota^{1*}, SHINBORI, Atsuki², HAYASHI, Hiroo², TSUDA, Toshitaka²

¹Graduate School of Infomatics, Kyoto University, ²Research Institute for Sustainable Humanosphere, Kyoto University

The Earth's upper atmospheric variations are generated under both the influences of the lower atmosphere and solar activity. Then, in order to clarify the generation mechanism of the atmospheric variations, we need to perform the integrated analysis of various observation data. However, various ground-based observation data and their databases of the upper atmosphere have been maintained by each institution that conducted the observations so far. Therefore, when researchers try to perform the comprehensive analysis of several kinds of observation data, there have been several problems of data search, acquisition, and analysis.

In order to solve the above problems, the "Inter-university Upper atmosphere Global Observation NETWORK: IUGONET" project was initiated in 2009 by the five Japanese universities and institutes (NIPR, Tohoku University, Nagoya University, Kyoto University, and Kyushu University). This project is proposed to construct a metadata database of observation data maintained by each institution and to develop the IUGONET Data Analysis Software (UDAS). This software is a plug-in software for THEMIS Data Analysis Software suite (TDAS) written in IDL, and can easily display several time-series plots of various observation data such as geomagnetic field, aurora, and neutral wind.

With the aid of the IUGONET metadata database and the analysis software (UDAS), we can access easily the data or database maintained by each research institution, and can perform the comprehensive analysis of various data sets in different fields. The UDAS has a lot of tools to display time series plots of various observation data, but does not include statistical test tools for correlation analysis of a pair of observation data. In this study, we aim to develop a package of statistical tests to judge whether the correlation analysis results are statistically significant or not. In the future, we plan to implement the statistical test package into the IUGONET analysis software (UDAS).

The statistical test package consists of five parts: First is calculation of cross correlation and decorrelation test for the value of correlation coefficient, second is power spectrum and coherence analyses and test for the coherence value, third is anomaly analysis to investigate the deviation from the reference variation with the dominant frequency in both the data determined from the coherence calculation, fourth is to judge whether the distribution of two data is the same or not, and fifth is to check whether observation data has significant trends (decrease or increase) or not. Due to changes of the observation condition or failures of instruments, observation data generally contain missing values and the time interval is not necessarily constant. Therefore, this package of statistical test includes several data processings such as linear interpolation and exclusion of missing value, in order to align the number of two subject data points.

To evaluate the effectiveness of our developed statistical test tools in this package, we applied the trend test to the long-term variation in the altitude distribution of meteor echoes obtained from the meteor wind radar at Kototabang. This instrument has been operated for a long period from November 2002 to present by the Research Institute for Sustainable Humanosphere, Kyoto University. As a result, the altitude of the maximum meteor echoes does not show a significant trend (decrease or increase) between 2003 and 2011 on the basis of the trend test at significant level of 1%. This result suggests that the altitude distribution of the density of the upper atmosphere around the meteor height almost do not change during this period. Therefore, it can be concluded that global warming is not recently in progress.

Keywords: IUGONET, analysis software, correlation analysis, statistical test, meteor, trend

Data management for the International Polar Year 2007-2008

KANAO, Masaki^{1*}

¹National Institute of Polar Research

Diverse data accumulated by many science projects make up the most significant legacy of the International Polar Year (IPY2007-2008). The Polar Data Center (PDC) of the National Institute of Polar Research (NIPR) has a responsibility to manage these data for Japan as a National Antarctic Data Center (NADC) and as the World Data Center (WDC) for Aurora. During IPY, a significant number of multidisciplinary metadata records have been compiled from IPY- endorsed projects with Japanese activity. A tight collaboration has been established between the Global Change Master Directory (GCMD), the Polar Information Commons (PIC), and the newly established World Data System (WDS).

Keywords: International Polar Year, National Antarctic Data Center, Data Management, Metadata Portals, Polar Information Commons, World Data System

Various applications of Markov random field model to earth sciences

KUWATANI, Tatsu^{1*}, Kenji Nagata¹, Masato Okada¹, Mitsuhiro Toriumi²

¹Graduate School of Frontier Sciences, University of Tokyo, ²IFREE, JAMSTEC

Recent development of measurement and observation techniques makes it possible to obtain a large amount of spatial and temporal data sets in earth sciences. However, it has still been difficult to extract geological and geophysical information, because available data usually have large noise and uncertainty. Therefore, the statistical analyses of data sets are essential for the objective and quantitative geological and geophysical interpretation. The Markov random field (MRF) model is a Bayesian stochastic model using a generalized form of Markov chains that is often applied to the analysis of images, particularly in the detection of visual patterns or textures (e.g., Geman and Geman 1984). The MRF model assumes that the spatial or temporal gradients of physical properties are relatively small compared with the measurement noise and analytical uncertainty. The MRF model acts as a low-pass filter to extract accurate spatial or temporal variations of physical properties. By the Markov chain Monte Carlo (MCMC) approach, this model can determine the appropriate bandwidth from the statistical properties of the observed data. Recently, several studies have used the MRF model to extract the true physical properties from noisy observational data sets, for example, in brain science (e.g., Watanabe et al. 2009). By the Bayesian probabilistic approach and their flexible formulation, the MRF model has a potential to deal with non-statistical uncertainty. Moreover, it can incorporate prior information into analyses quantitatively. We apply the MRF model to two inversion problems in earth sciences: one is a pressure-temperature inversion from compositional data of zoned minerals (Kuwatani et al., in press), and the other is an inversion of fluid distributions from observed seismic velocity structure. In this presentation, we will discuss effectiveness and broad applicability of the MRF model in earth sciences.

Simulation and Visualization of Liquid Gallium Convection

Atsuya Furuta¹, MASADA, Youhei^{1*}, Akira Kageyama¹

¹Graduate School of System Informatics, Department of Computational Science, Kobe University

In order to investigate the effect of magnetic field and rotation to liquid metal convection, Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Hokkaido University have collaboratively performed laboratory experiment for liquid gallium convection. Since the opacity of liquid gallium is high enough to prevent us from using optical measuring equipments, Ultrasonic Velocity Profiling (UVP) technique is employed for the experimental measurement. However, since the UVP can provide us only the information of one-dimensional distributions of fluid velocity, we have no means of studying three-dimensional spatial structures of magnetic and velocity fields which are essential for getting the convective properties.

In this work, we made a complementary numerical study, with using Earth Simulator 2, on liquid metal convection which can reproduce the laboratory experiment. In addition, for the multilateral and multidimensional analysis on the simulation data, we developed an original visualization software named "Gallium Field Visualizer (GFV)". The GFV visualization enables us to study three-dimensional structures of the liquid metal convection, which can not be obtained in laboratory experiments.

As the numerical setting, we adopted a rectangular box with the same aspect ratio as the vessel used in the laboratory experiment and analyzed the thermal convection for the following three models: i) the model with no magnetic field and no rotation, ii) the model only with magnetic field, and iii) the model only with rotation. In the model i), we confirmed that the convective structure is gradually changed from the coherent one to the turbulent one with the increase of the Rayleigh number for the system. In the magnetized model ii), which has almost the same initial setting as the actual laboratory experiment, we found the formation of the convective roll structure which was discovered in the experiment. Furthermore, the GFV visualization yielded additional findings, that is the helical flow along the convective roll and the concentration of magnetic fields by the convective converging flow. For the model iii) which precedes the laboratory experiment, the convective roll breaks up into the smaller scale columnar vortices aligned with the rotation axis with the increasing rotation velocity. When applying the particle tracer function installed in the GFV, we found the helicity reversal in the vortex column between upper and lower portions of the simulation domain.

The numerical simulation and three-dimensional visualization of the liquid gallium convection could provide us not only the information complementary for the laboratory experiment, but also the new findings which might serve as guides for future experiments. This work demonstrates that the collaborative research in simulation, 3D visualization and laboratory experiment should promote further understanding of the liquid gallium convection.

Keywords: MHD, Numerical Simulation, Scientific Visualization, Liquid Metal Convection, Geodynamo

Visualization Software for Immersive Virtual Reality Environment based on VR Juggler

MENO, Daisuke^{1*}, KAGEYAMA, Akira¹

¹Graduate School of System Informatics, Kobe University

To analyze large scale 3-dimensional data, the modern virtual reality (VR) technology will play important roles in future simulation studies. Various VR visualization programs have been developed to date, including our original VR visualization software VFIVE. However, almost all of the previous VR software are based on CAVElib which is a de facto standard commercial library for VR environments. To overcome practical difficulties of CAVElib, we are developing a new visualization software based on VR Juggler which is an open source free software library, instead of CAVElib. Our recent development of new VR visualization software based on VR Juggler that will replace VFIVE will be reported in the talk.

Keywords: visualization, virtual reality, CAVE, VR Juggler

A proposal of new visualization style: Interactive analysis of multiple movie files with fixed view points

YAMADA, Tomoki^{1*}, KAGEYAMA, Akira¹

¹Graduate School of System Informatics, Kobe University

A challenge in supercomputer simulations is the difficulty of visualization which is usually applied as a post process, after the simulation.

Data size, data complexity, and data transfer time are rocket up as the scale of a simulation grows.

To overcome the difficulties of the post-process visualization, we propose a new visualization style.

This is a kind of real time visualization in which visualizations are applied in the simulation time on the same computer, which means there is no need of the post process for the visualization.

However, a serious problem of the real time visualization method is that you cannot interactively change the viewpoint or visualization parameters of the output images or a movie.

To resolve this, we propose to place thousands (or millions in future) of view points, surrounding the target simulation region.

Each camera has multiple visualization parameters and therefore produces multiple visualization movies from the view point, in accordance with the advancement of the simulation time.

The output of simulations in this visualization style are thousands to millions of movies with the size of order of TB, rather than raw numerical data of the size of order of PB.

To analyze the output data, a special "movie player" is required that can play a movie, extracting proper sequence of images from the thousands of movie files.

The player should be able to interactively analyze the data by smoothly changing the virtual view point, to realize smooth rotation or zooming.

To demonstrate this new visualization style, we have developed prototype programs and applied them to a simulation data of seismic wave propagation by Prof. Furumura (U. Tokyo).

Focusing the simulation region, 130 cameras are placed on a surrounding spherical surface with the Yin-Yang grid point distribution.

We can smoothly, or interactively, see the wave propagation process from any position among 130 viewpoints by smoothly changing the viewpoint by typing a key on the keyboard.

Keywords: data visualization

Spatio-temporal modelling of Vegetation Index using MapReduce and Hadoop

NISHIMAE, Kou^{1*}, HONDA, Rie¹

¹Department of Applied Science, Kochi University, ²Rie Honda

Aiming at constructing a large-scale spatio-temporal data mining system in the Earth Science field, MapReduce and Hadoop, which is a framework for distributed data system, was examined. Extraction of time series data from a GIMMS dataset (images of vegetation indices) and temporal modeling using logistic function via ML method was implemented on Hadoop and MapReduce and its scalability was examined.

Keywords: data mining, Hadoop, MapReduce, GIMMS

Evaluation of uncertainty using Evidential Support Logic, case study of the research on estimation of uplift rate

NAKAYASU, Akio^{1*}, DOKE, Ryosuke¹, URABE, Atsushi², ONO, Eisuke², NIIZATO, Tadafumi¹

¹Japan Atomic Energy Agency, ²Niigata University

Various uncertainties exist in the data using in the research of geomorphology and geology. When the development process of the geological environment is restored using the data with these uncertainties, the result of the model or simulation inevitably includes uncertainties derived from the uncertainties of data. Especially, in the geological environment model dealing with chronological change of the site (Site Evolution Model) which consists from various kinds of data, the quality assessment/control in each data is important.

In this study, the factors of the uncertainties occurred in the process of data acquisition for the estimation of uplift rate, which is one of the data for drawing the topographic evolution, are analyzed by using Evidential Support Logic (ESL). The result of this study is assumed to be used as a tool for extracting the factor of uncertainties in the planning of the investigation, and for controlling the quality of results in the implementatin of the investigation.