Simulation on spectral cross-calibration of NDVI from MODIS, ASTER, and Landsat 5-TM

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Spatio-temporal changes in terrestrial vegetation are of significant importance for understanding environmental issues including global warming. Numerous earth observation satellites have been launched and operated for monitoring the earth surface. For example, the series of the Landsat satellite that provides 30m patial resolution (Landsat 5-Thematic Mapper (TM), Landsat 7-Enhanced Thematic Mapper Plus (ETM+), and Landsat 8-Operational Land Imager (OLI)) have been operated since 1980s. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) (15m spatial resolution) and Moderate Resolution Imaging Spectroradiometer (MODIS) (250m spatial resolution) onboard Terra have made measurements of the earth surface for more than 16 years. The spectral data obtained by the multiple sensors can provide long term monitoring of terrestrial vegetation over regional/global scale. The sensor specification such as spectral response function, however, shows differences across sensors, resulting in producing systematic errors in the data product (e.g. vegetation indices). It deteriorates the consistency among the data product of vegetation indices from multiple sensors. We developed the cross-calibration algorithm for reducing the errors among Enhanced Vegetation Index (EVI) due to differences between spectral response functions of MODIS and Visible and Near-infrared Imaging Spectrometer (VIIRS) (375m spatial resolution). The algorithm was implemented to actual sensor data of MODIS and VIIRS that were Climate Modeling Grid resolution (0.05 by 0.05 degree) for the cross-calibration and showed potential utilities of the developed algorithm [Obata et al., *Remote Sens.*, 8(1), 2016].
In this study, equations of Normalized Difference Vegetation Index (NDVI) for ASTER and Landsat 5-TM are cross-calibrated with reference to MODIS NDVI based on the developed algorithm. The hyperspectral reflectances derived by Earth Observing-1 Hyperion are used to simulate reflectances of the multispectral sensors. We then evaluate systematic errors among NDVIs between MODIS and ASTER/Landsat 5-TM and show results of the NDVI cross-calibration.

Keywords: NDVI, Cross-calibration, MODIS

Utilization of Elevation and Borehole Data of Hanoi City, Vietnam

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In Hanoi, the capital of Vietnam, environmental problems (land subsidence, flood, groundwater pollution and so on) have been increasing in recent years. The main reason is rapid urbanization and water control. In the rainy season, flooding occurs by heavy rain. Because the discharging water system is very old. Sometimes, buildings are sinking under the ground slowly because of the subsidence. The reason is excessive pumping of groundwater. Hanoi city is depend on the groundwater for the daily life water. These problems are related to the geography and subsurface structure of Hanoi city.
In this study, we collected the elevation data and borehole data through Hanoi University of Mining and Geology. Firstly, we need to generate the DEM (Digital Elevation Model) using the elevation data. DEM is a digital representation of ground surface topography and the most important element of topographic analysis. Secondly, we analyzed the borehole data for well construction of Hanoi city. We input it the developed borehole database for share with Vietnamese researcher. Finally, we constructed the 3D geological model of Hanoi city and visualized it using GRASS GIS.
Research area is the center part of Hanoi city, Vietnam and covers a range of lat. 21°00′00″ to 21° 04′22.5″ and long. 105°47′30″ to 105°51′52.5″. The coordinate system is VN2000. Hanoi is located on Red River Delta, this area is underlain by the Pleistocene and the Holocene sedimentary rocks. The Pleistocene rocks are divided into the Lechi Formation, Hanoi Formation and Vinh Phuc Formation. The Holocene rocks are divided into the Hai Hung Formation and Thai Binh Formation.
49 maps of an elevation survey points were collected through Hanoi University of Mining and Geology. The scale of this map is 1:2,000. The research area is 8km x 8km, and the number of survey points is 16,745. We generated a DEM based on the surface estimation method, we call it BS-Horizon (Nonogaki et al., 2008). The very subtle elevation gaps are significantly recognizable on it.
160 borehole data of Hanoi city was collected through Hanoi University of Mining and Geology. Each borehole data is a non-core drill data for the well construction. We picked up some information from the borehole data. The well name and drilling point can be found from the borehole data. The drilling point was described as the EPSG Geodetic Parameter Dataset (28418, Datum; Pulkovo 1942, Projection; Gauss-Kruger zone 18). Each thickness and lithofacies can be found from the borehole data. However, the description of lithofacies were not standardized. Therefore we unificated the geological description by Japanese standard, JASIC (Japan Construction Information Center Foundation) description. We classified 30 types of descriptions.
We outputted each geological boundary surface data from the borehole data and estimated DEMs of the geological boundary surfaces for 3D geological modeling using the same method of the topographic DEM.
The spatial distribution and the relation of geological units are expressed in the logical model based on the fundamental field data and the knowledge. The 3D geological model is composed the DEMs of the geological boundary surfaces and the logical model. We visualized the 3D geological model using GRASS GIS.
In this study, we constructed the 3D geological model using the borehole data of Hanoi city. This

is useful not only for the elucidation of geological structure of Hanoi city but also for the provision of the basis data to various fields. It is important to consider the urban sustainability of Hanoi city as in improvement of urban infrastructure and disaster prevention. Future works of this study are to develop the accessible 3D geological modeling system using Web-GIS.
This work was supported by JSPS KAKENHI Grant Number 24251004.

Keywords: DEM, Borehole data, 3-D geological model

Development of software " COREROKU " to support the geological analysis by high-quality core sampling information

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High-quality core sampling system is currently being evaluated in dam constructions and landslide controls where severe geological risk assessment is required in order to perform a highly accurate geological analysis. Core samples taken from high-quality core sampling system provide fine deformation structure and detailed geological change. The quality and quantity of geological information taken from those samples are well suited for application as compared to a usual boring survey. On the other hand, by the development of digital photography technology, more high-definition and large capacity image information are becoming available immediately after sample collection. It is expected to link image information with interpretation information as a database. However, the core samples deteriorate rapidly due to its observation, analysis and environmental condition. Therefore, it is necessary to make speedy information acquisition for an efficient analysis. New software "COREROKU (Koaroku)" is under development to solve these issues for operational efficiency of high-quality geological interpretation, quantify and data compiling. The most representative feature of “Koaroku” is a quick visualization of columnar section and graphs by arbitrarily combined indices. This feature enables to take panoramic view of whole geological situation at early core observing stage which is expected to support professional engineers to make more quantitative analysis for time reduction and operational efficiency. This software is expected to be an information sharing tool in practical business.
In data entry function of "COREROKU (Koaroku)", high-definition core sample images are used as a background image and core sample observation is recorded in clear and easy procedure. Main indices for data entry are type of surface structure, gravel shape trace, particle size, sedimentary structures, inclusions required for sedimentary facies analysis , a variety of test information for statistical analysis and not limited to basic interpretation indices corresponding to the JACIC basic criteria column. It is possible to enter surface structure data , mapping and stereo structural analysis when borehole-wall images are collected. In addition, columnar section and geological structure information can be imported to a three-dimensional geologic analysis system and used for analysis.
In this presentation, we will refer to our developing software including new function and performance being explored in ongoing operations.

Keywords: High-quality core sampling, geological analysis, information processing, software, COREROKU

Browsing System for Borehole Data and Geological Map using FOSS4G

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After the 2011 off the Pacific coast of Tohoku Earthquake, disaster mitigation is a growing concern among the public. In particular, subsurface geological condition in urban areas is one of the biggest public concerns. However, most of existing geological Web services provide insufficient data for assessing subsurface geological condition. In order to improve public understanding of subsurface geological condition, a browsing system for geological data were developed focusing on intelligibleness and user-friendliness based on Free Open Source Software for Geoinformatics / Geospatial. The system shows high-reliable borehole data and a geological map accessible to the public on the Web using the Leaflet JavaScript library. The borehole data are mainly provided in XML/PDF format, which are compliant with the specifications of borehole data by Japan Construction Information Center Foundation (JACIC). These were obtained by the drill surveys conducted in the northern part of the Chiba Prefecture by the Geological Survey of Japan (GSJ). The geological map was provided in a tile set of PNG images. The map was generated by computer drawing from a three-dimensional geological model, which was constructed based on borehole data and geospatial data such as Digital Elevation Models (DEMs). Future works are to implement functions of searching database for borehole data, generating geological cross section, and visualizing geological model in three- dimensions.

Automatic extraction of frequency sweep rate of chorus from a huge data set of Akebono

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Chorus emission is one of the most popular plasma waves observed in the Earth's magnetosphere. It has a distinctive feature in spectrum, that is, frequency sweep in a very short time period. The chorus is known to be generated at the magnetic equator and propagates to higher latitude along a magnetic field line. Its generation mechanism has been controversial for many years. In recent years, a theory was proposed that growth of the chorus is caused by a non-linear mechanism. An important point of the theory is a dependence of the frequency sweep rate on wave amplitude.
We performed a statistical analysis of the dependence using data obtained by the Akebono satellite. The Akebono satellite had observed plasma waves in the inner magnetosphere for 26 years. In order to find chorus emissions in the huge data set automatically, we adopted a modified template matching to the data set. One of the essential modifications is that intensity distribution of the template is determined according to that of target chorus elements. By this method, we successfully extracted chorus elements. We, then, investigated relations between frequency sweep rates and wave amplitudes of the extracted chorus elements. As a result, positive correlation is found between them.

Keywords: chorus emission, Akebono satellite, automatic extraction

In-situ visualization for spherical simulations using Yin-Yang grid and its variant

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We propose an in-situ visualization method for computer simulations in the spherical geometry using the Yin-Yang grid. Numerical data that are produced by supercomputer simulations are usually stored in a disk system before visualization processes. While the post-process visualization approach is becoming impractical these days due to the exponential growth of the simulation size, another approach to the visualization, called in-situ visualization, is gaining attention. In the in-situ visualization, both the simulation and visualization are applied simultaneously on a supercomputer. The output of an in-situ visualization is a set of two-dimensional images, rather than three-dimensional numerical data. The size of the output in an in-situ visualization is not a serious bottleneck on the contrary to the post-process visualizations. In this study, we focus on supercomputer simulations in the spherical geometry that uses the Yin-Yang (or recently proposed Yin-Yang-Zhong) grid.Although the Yin-Yang grid system was originally proposed for geodynamo simulations, it is applied in various fields such as geophysics, astrophysics, image processing, and so on, and the data are visualized in the post-process. The demands to visualize them with the in-situ method will be intense in future. Although general-purpose visualization applications with built-in in-situ visualization features exist, they are difficult to use on a supercomputer. Therefore, we propose an in-situ visualization method that has the following functions:(i) It is suitable for Yin-Yang(-Zhong) grid simulations; (ii) it has minimum visualization features; (iii) it is easy to use for simulation researchers; and (iv) it does not damage the simulation speed. We report the development of a Fortran90 library for this in-situ visualization method and its applications to MHD (magnetohydrodynamics) simulations in the spherical geometry.

Keywords: scientific visualization, in-situ visualization, spherical system, Yin-Yang grid, Yin-Yang-Zhong grid

New data transfer technique from Syowa via INTELSAT

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A communications satellite (INTELSAT) data receiving system with a 7.6m-diameter parabolic antenna was installed at Syowa Station in February 2004. So far, data transfer have been carried out using from the Antarctica station using the satellite network. The current bandwidth of the INTERSAT for data transfer between Syowa and NIPR (National Institute of Polar Research) in Tokyo is 3 Mbps. Since there is inevitable latency (RTT 500 msec) in between Syowa and NIPR, general file transfer applications, such as FTP, rsync, rcp and so on, don’t show good throughput. It is due to restriction of TCP function on networks with large latency (and packet-loss). The SteelHead provided by Riverbed is one of the WAN accelerators for long-distance data transfer. It intercepts TCP on both sides of the network, and accelerates TCP connection replacing with its own data transfer technologies.
The other role of the SteelHead is to control QoS of multiple data tarnsfers. Several projects at Syowa Station in many research fields are conducted so far, and data transfers are independent in principle. There needs a traffic control of network connections between Antarctica and Japan. Network managers at NIPR give priorities to each data transfer project, and the SteelHead allocates bandwidth to each network connection. However, this QoS control simply sets highest and lowest bandwidth. Total traffic could be lower than 3 Mbps in case that several traffics are lower than the given maximum bandwidth according to the QoS table.
Herein we propose a new data transfer protocol to work on the transport layer; the HpFP (High-performance and Flexible Protocol). This protocol is a connection-oriented protocol to works on the top of UDP. It provides us with a stream-type of reliable data transfer. Inside the HpFP, there are several ingenious attempts. One of the attemps is to set an internal target throughput to control pacing of sending packets. This parameter setting is time-dependent; the target throughput is derived from information of network monitored by the HpFP. The HpFP is able to detect unused bandwidth at every moment, then dynamically allocates the HpFP data connection. We discuss how effectively the HpFP covers the unused bandwidth on the condition of SteelHead control on the INTERSAT networks.

High-performance and Real-time Processing of Sensing Data via NICT Science Cloud

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In many scientific fields, most data are digitized and handled on computers and networks. The data files are getting larger in size and numbers. Science clouds, which are equipped with both flexibility and specialty applicable for countless scientific studies, are called upon to play important roles as an infrastructure of big-data sciences and inter-disciplinary studies. The NICT Science Cloud is designed to work with functions of data crawling and transfer, data preservation and management, and data processing and visualization. We have developed applications, tools, systems and services designed for these three functions (especially for Earth and space environmental sciences) installed on the NICT Science Cloud. By applying these functions to each sensing project, researchers are able to advance their studies. In this paper, we first introduce the NICT Science Cloud. We next report our 2-years applications of the cloud system based on several long durational satellite data processing. Finally, I propose a design to make progress of various types of sensing projects; real-time data processing and archived data processing of remote sensing and satellite observations.

Cyber Earth: A new technical approach for global studies of Earth

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In the present paper, the author proposed a concept of the Cyber Earth as a basic approach for the global understanding of the Earth system. In order for our global understandings from a variety of observation and simulation data of Earth sciences, we need a methodology to analyze huge size of big science data. The Cyber Earth is a concept to declare that, for our global understandings, mash-up of information and communication technologies for big data plays an important role. This concept is based on several technological ideas, such as data centric/intensive science, the fourth paradigm, science cloud, big-data science. All of the data, observation data and simulation data, are once transferred and stored on a science cloud system. Data preservation and data stewardship is important since most of the data is so precious that they are never observed again at the observed time and location. Big data processing, including visualization, is also important. The data processing must be applicable for any types of digital data from either Earth observation or simulation. Integrated data processing technology for such variety of data type is preferable. The Cyber Earth is composed of three methodologies; the Network Earth, the Digital Earth and the Virtual Earth. The Network Earth is a concept that role of network is important for data transfer and collection to the cloud. For global monitoring we often build up global observatories on the Earth. Integrated operations and easy management of the remote sites are significant for labor-saving. The Digital Earth is a concept that long-term data preservation is one of the most expected functions to a science cloud. Data files must be saved and managed under DR (disaster recovery) environment. Easy data publication should be functionally synchronized with data preservation. The Virtual Earth is a concept that every digital data must be processed or visualized to be shown on the same framework with other data. Inter-disciplinary data preview, in space and/or in time, makes our global and functional understanding of the Earth system. Immersive visualization may work effectively to understand or discover any interactions between data.

A high-bandwidth virtual remote storage (HbVRS) system on long fat network (LFN) and its application

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Science cloud is a cloud system specialized for data intensive/centric science, which is based on a concept of the fourth paradigm proposed by Jim Gray in 2009. However, only a few science cloud systems have ever yielded tremendous scientific results so far. High-bandwidth storage I/O is one of the important issues to be overcome for big data sciences. In the study, we propose a high-bandwidth virtual remote storage (HbVRS) tool using a distributed file system (Gfarm) and a UDP-based data transfer protocol (HpFP). The tool is based on our examination of parallel HpFP data transfer in 10 Gbps using a long-distance 10G network (long fat network: LFN) between Japan and USA crossing the Pacific. We installed an application to draw a set of time sequential graphic files using the tool on the NICT Science Cloud. We successfully read data files in order of time sequence from a virtual storage as fast as more than 20 Gbps. The present results suggest that client hosts connected with a long fat network will be able to access to big data stored in cloud storage wherever over the world it is located. An application is demonstrated using the HbVRS.

STARS touch: A web-application for time-dependent observation data designed for world data systems

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In 2008, the International Council for Science (ICSU) established the World Data System (WDS) to ensure the long-term stewardship and provision of quality-assessed data and data services to the international science community and other stakeholders. One of the objectives of the WDS is to support and make progress of interdisciplinary and cross-over studies data analyses covering a variety of research fields. In 2010, the NICT Science Cloud, which is one of the projects of the National Institute of Information and Communications Technology (NICT), has initiated a sub-project to realize the WDS's concept of the interdisciplinary data activity. In this paper, we demonstrate potential capability of our Web application for interdisciplinary data analysis, which is now operated on the NICT Science Cloud. In the initial stage of the system development, we constructed a basic concept and an initial design of the Web application, taking into account our long-term experiences in data-oriented activities under the WDC (World Data Center) system of the ICSU, which was an ICSU's data program operated from 1957 to 2008, preceded the WDS. Based on our design, we have implemented the Web application for data plots on the basis of the HTML5 and the Ajax technologies. Data plots can be previewed on the Web application with higher usability and better handleability than those of traditional data-plot tools developed for multiple-datasets. We finally discuss feasibility and potential usefulness of the Web application for future interdisciplinary data-analysis activities of the WDS.

