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3D visual representation of geophysical fluid simulations on Google Earth and its transmission: the EXTRAWING project

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We introduce the EXTRAWING, an R/D project for novel and attractive representations of geophysical and environmental fluid simulations and effective transmissions of those results to the public. In this project, we have developed a technique to make the three-dimensional visualization results of those simulation datasets be represented on Google Earth. We have also developed a web application program based on the Ajax framework to observe those results on an internet browser. The name EXTRAWING is a coined acronym consisting of the initial letters of the words; EXploring and TRAveling the World INside Geoscientific data. The outline of the project is described below.

Most of graphical contents for geo-scientific data displayed on Google Earth are represented by following forms; point (zero-dimensional form) as information attached on each place, line (one-dimensional) as tracking results of tagged pelagic fishes and surface (two-dimensional) as a satellite image. What we should visualize is a volume dataset (three-dimensional form) obtained by a geophysical fluid simulation. It is needed to develop a novel way to represent three-dimensional feature of the dataset on Google Earth. Graphical contents data for Google Earth should be given as a geometric dataset, a set of polygons. Therefore, a volume rendering based on ray-casting is unavailable. Furthermore, the number of the polygons should be minimized to ensure fluid operability of Google Earth. It might be said that iso-surface representation, which needs a large number of polygons in order to extract three-dimensionally complicated distribution of fields, is not an appropriate way to display on Google Earth. We tried another volume rendering approach by piling color contouring images made from each slice of a volume dataset and mapped suitable opacity on each pixel of them. This approach has a great advantage in minimizing the number of polygons because this method needs only polygons same as the number of sliced surfaces.

Next, we consider how to transmit it to the public. Information transmission utilizing the internet is nowadays common practice. The simplest way to transmit our volume rendering contents for Google Earth is to install a web server for downloading those contents on the internet. However, this way imposes burdensome tasks on the user of those contents, such as installing Google Earth, downloading the content data and reference material, operating Google Earth functions and extracting features from the data. Such tasks are difficult for the people who are unfamiliar with Google Earth. Therefore, it is important to construct a system that everyone can easily access those datasets and comprehend the meaning of our simulation results without such difficulties. Under this consideration, we developed a web application program based on an Ajax framework with the Google Earth API library provided by Google Inc. The layout of this web application is shown in the figure. In designing the program, we concerned about user's computer environment (monitor size, browser type and version) and prepared several text documents (Google Earth, operating instructions, FAQ, etc.).

As the first release of EXTRAWING, we prepared two kinds of contents by simulation results; (1) temperature distribution in central Tokyo (shown in the figure) and (2) Typhoon No.4 of 2007. The MSSG model developed in the Earth Simulator Center is used in each of the simulations. In the case (1), the growth and collapse streaky structure in the temperature distribution are found in the graphical region of the figure. In the case (2), three-dimensional structures of the Baiu front lying on the Japanese archipelago and the typhoon located at southwest of Kyushu is visible.

This web program is available on wherever there is Internet-connected environment. The development of useful tools and visualization techniques, improvements, and the expansion of contents are future works of this project.

Keywords: EXTRAWING, Google Earth, visualization, volume rendering, web application, transmission of information