Vertical Earth: Databases for the Vertical Integration of the Layer Structure of the Earth System

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The comprehensive understanding of the Earth system requires the integrated usage of many types of earth observation data. But the integration is difficult at this moment. Why is it difficult? The main reason is in the fact that earth observation has been carried out for each layer of the earth, or for each X-sphere, and the result of observations has been archived in separate groups; in spite of this distributed archiving, there is little convenient method to connect the result of observations together. This paper focuses on this fundamental problem of earth science, and proposes a method for the vertical integration of earth observation data acquired for the multiple layers of the Earth system.

This paper refers to Geographic Information Systems (GIS) as the basic model of information integration. GIS has been playing an important role in the management of earth observation data. But its presence is not so significant in the management of earth science data in general, except for the management of land use data. We suppose that this is because typical GIS show advantage in the management of vector data (such as lines and regions), while less impressive for the management of raster data (such as satellite data and simulation data). However, the fundamental concept of GIS, namely the layer, shows a good correspondence with earth observation data acquired separately for each vertical layer of the earth system, so the layer is the concept fundamental to the overlay, search and visualization of earth observation data, which are heterogeneous for the vertical direction.

Another problem, that is, the results of earth observations are archived in multiple groups that may be distributed separately, can be solved using Web services such as Web Map Service (WMS) and other related Web services, some of which have been used in GIS communities for some time. These Web services are designed for interoperability between GIS servers, so the overlay, search and visualization across multiple groups is possible just by setting up servers that are compliant with these standards. The fundamental concept of Vertical Earth that we propose in this paper is thus the combination of vertical integration using layers, and horizontal integration using Web services.

We plan to start Vertical Earth with the following two datasets. The first dataset is earth observation data for the troposphere owned by National Institute of Informatics. These data are accessible at the Website - Digital Typhoon - (http://www.digital-typhoon.org), including 60,000+ typhoon images, 50+ years of typhoon track data, and 300+ million records of AMeDAS data. This database not only contains raster data (typhoon images), vector data (typhoon tracks), and in addition it contains textual data like typhoon-related news articles. The structure of the data is complex, but this may serve as a model case to learn about the integration of complex data structures of other earth observation data.

The second dataset is earth observation dataset for the geosphere, including geological data in the Antarctic area owned by National Institute of Polar Research. This data is now archived as paper maps, and the digitization of these maps are now an ongoing project. The digitized maps are used as layers and interconnected with other data in other areas using Web services.

This project is still conceptual work, but we plan to increase the number of participating groups so that we can set up the portal site of earth observation data with sufficient variety. The integration of versatile data enables the overlay of your data on other data acquired in other research areas, and this may lead to unexpected discovery which may not be visible before. The final goal of this research is to realize research environment to help understand important ideas of the earth environment.