

The Development Research of a Geographical Information System for Satellite Ocean & Atmosphere Remote Sensing

Chaoyang Fang¹, Hui Lin¹, Yuanzhi Zhang¹, Bingli Xu¹, Ge Chen²

¹ Institute of Space and Earth Information Science, Chinese University of Hong Kong
Shatin, N. T., Hong Kong
{fangchaoyang, huilin, yuanzhizhang, xubingli}@cuhk.edu.hk

² Ocean Remote Sensing Institute, Ocean University of China,
5 Yushan Road, Qingdao, China
gechen@ouc.edu.cn

As a powerful tool in storage, processing, analysis and visualization of geospatial information, Geographical Information System (GIS) has been applied in marine field by research institutes, government agencies and private sectors all over the world, and evolved to a series of Marine Geographical Information System (MGIS) after many years of focus on terrestrial (Wright, 1997;). The rapid application of GIS technology and the increasing number of scientific needs contribute greatly to the advancement of MGIS, especially in the last decade (Ji, 2003). However, the current commercial GIS software always meet obstacles when used in the application on the Deep Sea or Open Sea, instead of the coasts, estuaries and marginal seas, also many questions come forth, such as incompatible of the data format, can't accomplish the special analysis functions, and can't realize the representation format of the conceived information (Valavanis, 2000). Then a question puzzles both GIS and ocean community: whether GIS can be used in the real marine environment? In fact, the essence for this question is that the traditional GIS always handle the static state object with single phase base on the 2 dimensional map layers, but the Deep Sea and Open Sea is a high-dimensional dynamic environment, and most of environment attributes are manifested by a plumose distribution. So it is essential to develop a novel GIS platform to fit such environments, which can not only satisfy the requirements of the management, analysis and representation of this kind of environment data, but can also promote the improvement and development of the traditional GIS in order to adopt it to high-dimensional dynamic field.

Ocean and atmosphere are two interactive coupling systems and both of them are a multidimensional and dynamic fluid system, which means that the data properties have many similarities, and data analysis and representation functions always are universal (Fang, 2002). The satellite remote sensing has provided the marine and atmospheric observation and research with a brand-new dataset which has covered most of the parameters of the environment. With the advantages of wide range coverage, long time series and high resolution, those dataset has become a very important data source in the marine and atmosphere research step by step (Martin, 2004). In the light of the above consideration, it is determined that a developed type of GIS platform software —MAGIS, based on satellite remote sensing data, with global marine and atmospheric environments as its investigation object, will be designed and developed.

This research suggests the concept of double-core structure consisting of 5D data set and the functions of data analysis and visualization, on the basis of which, MAGIS has been developed. The management and organization of these two cores will be respectively done through the design and development of Marine and Atmospheric Spatial-Temporal Data Model (MASTDM) and Spatial-Temporal Work Flow

Management System (STWFMS). MASTDM, designed on the basis of overall analysis of the characteristic spatial-temporal scheme for data collection, and data requirements for analysis and visualization, is the bridge for integration of the three main functional modules of MAGIS, namely, data management, spatial-temporal analysis and visualization. By introducing the technology of work flow into the MAGIS, STWFMS supports the modeling and control of analytic research process, and is able to organize and dispatch the three functional modules through process model. MASTDM will be applied to complete seamless integration of the management, abstraction, analysis and presentation of satellite remote data, and the establishment of STWFMS has finished the conversion of MAGIS for a function-faceted utility system for satellite remote sensing data into a platform software that supports the process modeling for analytic study, and has provided the possibility of automatic application of the data. Base on the application of MAGIS, users can concentrate more on the designing of research scheme, without having to consider realization of various algorithms and the conversion of data formats among different procedures.

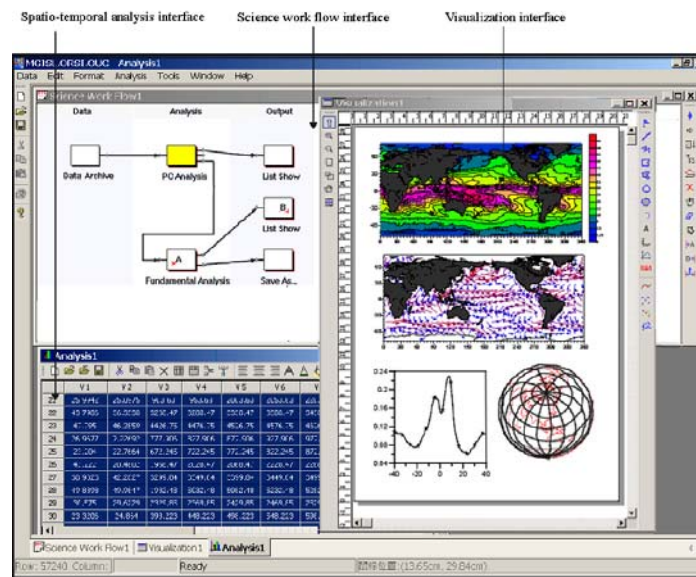


Figure 1. Typical main interface of MAGIS, which contain spatial-temporal analysis window, visualization window and scientific work flow window.

The MAGIS system is developed from the bottom layer with Visual C++6.0, and the primary development and debugging has been completed with the composition of almost 100,000 lines of codes. A typical main interface of MAGIS is shown in Figure 1, exhibiting the three main user interfaces of spatial-temporal analysis, visualization and scientific work flow. The spatial-temporal analysis user interface will mainly provide methods for various data processing and spatial-temporal analysis, while the visualization user interface provides presentation methods for various data and knowledge. Both the above two user

interfaces support functions of data management by which users can abstract data, and process the acquired data according to analysis and presentation needs. The third user interface supports the function of visualized SWF management, and can be used for establishment, set-up, running, saving and loading of scientific work flow process. Based on the MAGIS, system users can process by transferring various "methods" of the three functional modules through the three types of user interfaces. The system provides two operation modes for transferring "methods," namely, menu drive and business process modeling. Both the spatial-temporal and visualization user interfaces are based on menu-drive operation, which can activate and operate only one "method" at a time, while the scientific work flow user interface supports the operation mode of business modeling, and allows pre-setup of method sequence for automatic operation.

Through development and application of the MAGIS, it has been proven that the double-core structure of data and method can conveniently and successfully support the analytic study of both the large- and mesoscale phenomena of the marine and atmospheric environment on the basis of remote sensing data obtained by satellite. In future, the general goal for system improvement and perfection shall be the integration of data of more variety, longer temporal sequence; the integration of more analytic methods and models that are more effective; and the integration of more presentation methods for multidimensional dynamic data that are more advanced.

BIBLIOGRAPHY

- Clancey, William J., 1997 *Situated Cognition: On Human Knowledge and Computer representations*. Cambridge University press. The Edinburgh Building, Cambridge CB2 2RU, United Kingdom. ISBN 05214449004, pp 406.
- Guarino N., *Semantic Matching: Formal Ontological Distinctions for Information Organization, Extraction, and Integration*. In M.T. Pazienza (ed.). *Information Extraction: A Multidisciplinary Approach to an Emerging Information Technology*. Springer Verlag: 139-170, 1998.
- Fang C. Y., *A TOPEX-Based Marine Geographic Information System for Prediction of Extreme Sea Surface Wind Speeds*. *J. Oce. Uni. Qingdao*. (2002) 789-794
- Ji W., *Marine and Coastal GIS: Science or Technology Driven?* *Marine Geodesy* (2003) 1-2
- Lockwood M., *Marine geographic information systems: What sets them apart?* *Mar. Geo.* (1995)157-159
- Valavanis V. D., *Geographic Information Systems in Oceanography and Fisheries*. Taylor & Francis London (2002)
- Wright D.J., 1997, *Data from the deep: Implications for the GIS community*. *International Journal of Geographical Information Science*, 11, pp. 523-528.