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Conceptual data models in Earth Sciences and GIS

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As observational and model output datasets in the FES (Fluid Earth Sciences, mainly oceanography and atmospheric science) increase in resolution, there is an increasing demand for information systems that interoperate between the GIS and FES realms However, differences in the way the two communities think about their data can give rise to difficulties in integrated analysis and display of datasets from the two disciplines.

Motivated by the Information Society's needs and possibilities, the GIS community has been working on solutions for "importing" FES datasets. GIS data models have been reshaped and extended to accomplish such ambitious task. International initiatives (e.g. ISO TC 211 and OGC) have released geo-information standard models conceived to support general interoperability. These efforts lead to the definition of "more general" models for geospatial information. Such models distinguish two kinds of geospatial information: boundary and coverage data. Boundary data is often called "vector data" and is almost always feature oriented. Generally, FES datasets are thought of as coverages and they often involve grid-oriented data.

In order to understand how much GIS data models are suited for representing FES datasets, it is useful to consider the following questions: 1. How important is the geographic aspect for Earth Sciences data? 2. How well is time modeled? 3. How much of FES semantics is captured?

In the Web era, these different concept models produce diverse content models generating disciplinary Markup Languages (MLs).

As the technology of web services accessible by computer programs evolves, the challenge for those studying the Earth from an interdisciplinary perspective is to develop

interoperable data models that can span the specific data models employed in individual disciplines. Moreover, these interoperable models have to be integrated with the semistructured framework of the Web itself. Only in this way it will be possible to develop visualization applications that afford the user an integrated view of datasets from different disciplines overlaid on societal and infrastructure impacts information from traditional GIS databases. Furthermore, it is crucial for the systems to evolve in such a way that the datasets themselves can be embedded into that semistructured graph which models Web documents/data.

A general, abstract view of differences between the data models of the two communities is presented, as well as a schematic description of where the data systems overlap and where they are distinct from each other. The well accepted netCDF and OpenGIS/ISO coverage data models are considered and presented. Examples of significant MLs for both communities are presented (i.e. GML and ncML), discussing a mediation solution approach (e.g. ncML-GML). A valuable framework, based on well-accepted protocol and data model interoperability standards is briefly presented and the experimentation of its adopted mediation solution is reported. This framework is based on technologies such as: Unidata's THREDDS Data Server, OGC's Web Coverage Service, OPeNDAP and ncML-GML. Lessons learned and future developments are discussed.