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The GEO Model Web Initiative for Environmental Model Access Interoperability

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In this presentation we introduce the GEO (Group on Earth Observation) Model Web concept discussing its principles, architectural nature, and possible implementation approaches. A special focus is dedicated to relevant challenges and open issues concerning environmental models integration. The relationship between the Model Web concept and the existing integration modeling frameworks and software environments is discussed as well.

Current capabilities for predicting the evolution of the Earth System are often inadequate. GEO has recognized this and is promoting several initiatives to address this shortcoming. One of them is the GEO Model Web initiative which focuses on enhancing interoperability of existing models, making them and their outputs more accessible and establishing multi-model systems.

The Model Web is developed in the framework of GEO GEOSS (Global Earth Observation System of Systems)as a specific task managed by the Architecture and Data Committee.

The Model Web notion was first introduced by Geller and Turner as "a concept for a dynamic network of computer models that, together, can answer more questions than the individual
models operating alone". This “is based on a philosophy that encourages modelers to provide access to their models and model outputs via standard "web services", which makes it easier for the models to exchange information. Growth of this network is predominantly organic and opportunistic” . This concept was adopted and extended by GEO for developing an open-ended, distributed, multidisciplinary network of independent, interoperating models –plus related datasets.
This Model Web general vision can be specified through a set of high-level features capturing the Model Web principles and providing an operational definition suitable for further elaboration towards its design and implementation, such as:
- To constitute a subset of the Web;
- To allow organic and opportunistic growth;
- To provide low entry-barriers for both users and resource providers.

As a high-level concept, the Model Web is neither an architecture nor a software framework, but a vision which may be implemented through different architectures and software frameworks. The lessons learned from different Information Technology domains suggest possible directions for the design and implementation of an effective Model Web realization. For instance the following IT domains provide valuable inputs for the Model Web realization:
- Distributed systems: Environmental models descriptions, instances, and related resources, can be deployed, in principle, on every node connected to the Internet.
- Web and Semantic Web: The architectural and technological solutions developed in the context of the Web and the Semantic Web can be replicated in the Model Web architecture to achieve high scalability and flexibility
- System-of-Systems approach: The System-of-Systems approach, which is successfully adopted in several global initiatives and programmes, provides means to integrate existing systems in the Model Web while maintaining them as independent and autonomous.

The Model Web principles pose several challenges independent of the specific architectural choices. In particular:
- Information modeling: the definition of a general information model is crucial for the Model Web. Resources such as model descriptions, model instances, model engines, and model services must be clearly defined.

- Simple interoperability agreements: to allow connection of environmental models in arbitrarily complex workflows it is necessary to adopt special interoperability arrangements. These should be as simple as possible in order to minimize constraints on model providers, and thus conform to the low-entry barrier principle.
- High performance: environmental models and their compositions are often complex and may require a large amount of storage and/or processing resources. The integration with the Distributed Computing Infrastructures (DCI) such as Grid, Cloud and HPC might provide the required capabilities.
- Long-term access: Environmental Models are often provided as a software implementation in the form of source code or running services. This poses problems of long-term preservation related to the software environment adopted.

Currently, there are several on-going initiatives and projects contributing to the Model Web development at different levels. They include: the GEO AIP (Architecture Implementation Pilot) proof-of-concepts, the GEO BON (GEO Biodiversity Observation Network) initiative, several projects funded by the European Commission (i.e. UncertWeb, EuroGEOSS, EGIDA, GeoViQua), NASA activities, etc. Other initiatives not directly related to the Model Web task provide or might provide relevant outcomes such as the integration frameworks development initiatives (e.g. OpenMI, nanoFORGE/nanoHub.org, IEMHub,ESMF, openModeller, etc).