UNDERSTANDING the Earth System—its weather, climate, oceans, atmosphere, water, land, geodynamics, natural resources, ecosystems, and natural and human-induced hazards—is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, reducing disaster losses, and achieving sustainable development. Observations of the Earth System and the information derived from these observations provide critical inputs for advancing this understanding.

The Group on Earth Observations (GEO), a voluntary partnership of governments and international organizations, was established at the Third Earth Observation Summit in February 2005 to coordinate efforts to build a Global Earth Observation System-of-Systems (GEOSS). As of November 2007, GEO’s Members include 72 Governments and the European Commission. In addition, 46 intergovernmental, international, and regional organizations with a mandate in Earth observation or related issues have been recognized as participating organizations.

The purpose of GEOSS is to achieve comprehensive, coordinated, and sustained observations of the Earth system to meet the need for timely, quality long-term global information as a basis for sound decision making; initially nine societal benefits are: 1) disasters; 2) health; 3) energy; 4) climate; 5) water; 6) weather; 7) ecosystem; 8) agriculture; and 9) biodiversity.

GEOSS builds on and adds value to existing Earth Observation Systems by coordinating their efforts, addressing critical gaps, supporting their interoperability, sharing information, reaching a common understanding of user requirements, and improving delivery of information to users.

GEOSS is a typical system-of-systems (SoS), aiming at adding values through synergy rather than building a system level capability from scratch. For this reason, GEOSS is being developed using the system-of-systems engineering (SoSE) approach. However, the scale and complexity of GEOSS pose many challenges.

For example, the GEOSS development process is quite different from examples of SoSE applications reported by private firms and governmental organizations. Those organizations usually have a hierarchical structure of specialized divisions to efficiently deploy the design of SoS. In contrast, while GEO is also an organization consisting of members that share the common objectives, it is a voluntary partnership of national governments and international nonprofit organizations.

The differences are more than just the contractual verses voluntary nature of the SoS. GEOSS has very large cultural and technical capability differences that impact the way the SoS needs to be constructed so that it effectively serves the customer base, i.e., the scientists, industry members, and government managers that create and use information for societal benefits. Discussions on how to modify and apply SoSE to GEOSS are found among the papers in this Special Issue such as “Using Architecture Modeling to Assess the Societal Benefits of the Global Earth Observation System-of-Systems,” by Martin, “System-of-Systems Architectural Considerations for Complex Environments and Evolving Requirements,” by Corsello, and “A System-of-Systems Engineering GEOSS: Architectural Approach,” by Butterfield et al. present efforts of developing data sharing infrastructure for GEOSS are discussed by Christian in “GEOSS Architecture Principles and the GEOSS Clearinghouse.”

In addition, to strengthen endorsement from GEO, participating countries, and organizations, it is crucially important to demonstrate concretely and quantitatively what kinds of benefits and values can be created through GEOSS. But how can we evaluate the benefits? This challenge is addressed by Fritz et al. in “A Conceptual Framework for Assessing the Benefits of a Global Earth Observation System of Systems” and “Valuing Weather Observation Systems for Forest Fire Management,” by Khabarov et al.

Another interesting issue in integrating data and system components is semantic inconsistency. There are many words in different languages used by different organizations and communities to address the same object or thought. Semantic and ontological issues are addressed by “An Information Semantics Approach for Knowledge Management and Interoperability for the Global Earth Observation System of Systems,” by Durbha et al.

To realize GEOSS, data processing and managing services such as transferring, visualizing, mining, and quality-controlling services have to be developed to ensure effective uses of large amounts of heterogeneous data. Examples of designing and developing data processing services are reported in “DataFed: An Architecture for Federating Atmospheric Data for GEOSS,” by Husar et al., “Design Principles and IT Overviews of the GEO Grid,” by Sekiguchi et al., “PVES: Powered Visualizer for Earth Environmental Science,” by Yasukawa et al., “GEONETCast—Delivering Environmental Data to Users Worldwide (September 2007),” by Wolf and Williams, and “An Advanced Quality Control System for the CEOP/CAMP In-Situ Data Management,” by Tamagawa et al.

Finally, implementation examples of SoSE in a similar environment to GEOSS are reported by “Land Cover Observa-

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The challenges of GEOSS have just started. We expect new and exciting innovations and efforts will be made and reported towards the success of GEOSS, which will lead to the improvement of welfare in the nine societal benefit areas. Finally, the editors would like to thank all the contributors and the reviewers for the publication of this Special Issue.

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