# Preface

## About this book

### *Background*

This book describes the scientific rationale and the specifications for the Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) in terms of concepts, conventions, infrastructure and services, that would meet future requirements of a global community facing increasingly challenges on a changing planet. With this in mind, the document provides the basis for the further development of GGOS over the next decade and beyond. GGOS is built upon the basis provided by the existing Services and Commissions of IAG and is one of the major IAG components. In order to maximize the benefits to users of the considerable infrastructure and resources available to these Services, the concept for GGOS and the strategy for its development and implementation require careful considerations of the future needs of society for geodetic observations and services.

Improvements to the International Terrestrial Reference Frame (ITRF) and the availability of geodetic observations of changes in Earth's shape, gravity field and rotation over the last few decades have been a major driver of scientific discovery. Further improvement can be expected to lead to more exciting discoveries, particularly in combination with emerging new observation technologies for monitoring the variability of the Earth's gravity field and surface deformations. In a broader sense, the geodetic reference frames and observations have contributed to a transition of many processes in society and are expected to continue to do so. This great potential for scientific progress in support of societal needs associated with an improved geodetic observing system motivated the process that led to this book.

The context for this book is the increasing societal and scientific need for Earth observations, and their dependence on an appropriate geodetic foundation as well as a continuous series of geodetic observations. There is a growing awareness that sustainable development, which is the agreed-upon leading principle and goal of the global community, cannot be achieved without sufficient knowledge about the state, trends and processes in the Earth system. This is manifested in the establishment of the Group on Earth Observations (GEO) with currently about 75 member countries. The main purpose of GEO is to facilitate the implementation of the Global Earth Observation System of Systems (GEOSS), with the vision for this system *to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information* (GEO, 2005a).

Geodesy provides the foundation for most Earth observations as well as crucial observations of changes in the Earth's geometry, gravity field, and rotation, which are all related to mass transport in the Earth system and the system dynamics. Therefore, geodesy is crucial for meeting many of the requirements for observations of global change and observations supporting studies of the Earth system. Providing the basis for precise positioning and navigation, geodesy is also crucially supporting or enabling many activities and processes in a modern society.

Realizing the importance of the geodetic reference frame and the contribution of geodesy to Earth observations, GEO has included a specific Task AR-07-03 "Global geodetic reference frames" in its Work Plan 2007-2009 and and as Sub-Task DA-09-2c in the Work Plan 2009-2011. Understanding the requirements for GGOS is a central goal of this task. The present book provides this input to the GEO Task.

The development of Earth observations takes place in a context where a considerable fraction of the funding for Earth observation infrastructure and research is allocated in response to major natural and anthropogenic disasters without a sufficiently well developed core infrastructure stable over time. Many satellite missions are research-oriented, whereas operational monitoring of many key indicators of the Earth system is insufficiently implemented (GEO, 2005b).

In geodesy, this situation is not much different. Current limitations in funding, often with a lack of appreciation of decision makers of the importance of the geodetic observing system for Earth observations and society at large, has led to the global geodetic community seeking yo provide better products and services based on incremental improvements to the system in an overall framework that severely limits the options for such improvements.

## *Scope*

The advent of the space-geodetic techniques, and the rapid improvement and growth of communication techniques and capacities, has launched a revolution in the field of applied and global geodesy. Moreover, geodetic imaging increasingly gains importance, and the integration of the new techniques and methods into the traditional point-based approach of geodesy poses a major challenge. Therefore, it is timely to assess thoroughly the user requirements for the geodetic observations and products, and based on these requirements to design an optimal future system, which makes use of the maturing space-geodetic techniques as well as emerging imaging techniques. In order to do so, the authors for the contributions collected in this book had to take a fresh approach to the problem, not only with respect to the infrastructure but even more so concerning the underlying concepts, including the conventional approach to geodetic reference frames. Some of the concepts described or proposed here contradict current "best practices" and time will tell whether these new concepts will facilitate significant progress or whether they will have to be modified.

The authors of the contributions collected in the book do not attempt to assess current systems, concepts, products and services, but rather take a new look at the problem of building a geodetic observing system. The starting point is a rigorous review of the societal and scientific problems that require geodetic observations for their solution. This analysis leads to a set of general user requirements. These requirements are then, in a second step, used to derive functional system specifications. A third step focuses on the design of a system that would meet these specifications.

Collectively, the chapters of this book provide:

(1) a description of the scientific and societal problems, as well as practical applications that benefit from geodetic observations, services and products;
(2) a comprehensive overview of the user requirements for geodetic observations and products as derived from a broad range of societal benefit areas and scientific requirements;
(3) the functional specifications for a geodetic observing system capable of meeting the user requirements;
(4) a concept for future realizations of a (terrestrial) reference system able to meet the user requirements;
(5) the design of a system capable of addressing the functional specifications, in terms of conventions, techniques, infrastructure, and data analysis; and
(6) considerations and recommendations for the system implementation.

## *The anticipated audience*

This book is a comprehensive document describing the background rationale for GGOS. It was written by a team of Chapter Lead Authors, each supported by Chapter Writing Teams. Besides including geodetic experts in all relevant fields, the chapter teams also include experts from other fields of Earth sciences and Earth observations. This book serves two purposes: (1) to inform users of Earth observations (in particular, GEO) of the potential of GGOS, and (2) to ensure that the GGOS community is aware of the users' needs and requirements so as to integrate GGOS into GEOSS for maximum mutual benefit. Thus, this book seeks to facilitate communication across several sectoral and discipline boundaries, including those between geodesy and other Earth sciences, between scientists and operational agencies, and between GGOS and GEOSS.

## *Documents consulted*

Geodesy has a long tradition of assessing the requirements of society and of projecting these into future developments of the geodetic techniques and observing systems. This book continues this tradition, and it therefore benefited from a number of reports made available over the last four decades. These reports include, but are not limited to, the “Williamstown Report” (Kaula, 1970), the “Erice Report” (Mueller & Zerbini, 1989), the report on geodesy in 2000 prepared by the U.S. National Research Council in 1990 (Commission on Physical Sciences, Mathematics, and Applications, 1990), the “Coolfont Reports” (NASA, 1991a,b,c), the gravity report by the U.S. National Research Council (Commission on Geosciences & Resources, 1997), the *Living on a Restless Planet* report of the Solid Earth Science Working Group of NASA (Solomon & the Solid Earth Science Working Group, 2002), the report of an InSAR Workshop (Zebker, 2005), and the recent ESA document *The Changing Earth* (Battrick, 2006).

In the frame of the Integrated Global Observing Strategy - Partnership (IGOS-P) and GEO, several reports documented the needs for Earth observations in several societally relevant fields. Examples are the documents of GEO, such as GEO (2005a,b), the IGOS-P Theme reports (e.g., IGOS-P Ocean Theme Team, 2001; Lawford & the Water Theme Team, 2004; Marsh & the Geohazards Theme Team, 2004; Townshend & the IGOL Writing Team, 2004; Key & the IGOS-Cryo Writing Team, 2004), as well as reports produced by the various United Nations (UN) Agencies and programs. The latter include in particular the recent UN Water report (United Nations, 2006).

In a number of recent reports, user requirements for geodetic observations have been considered. Some of these reports are focused on national developments (e.g., Williams et al., 2005), improvements to the current situations (e.g., Plag, 2006a), or single technological aspects (such as Niell et al., 2006). Of direct importance for this book are the documents and publications produced by IAG scientists and teams focusing on GGOS, namely the papers in Rummel et al. (2000) and the GGOS Implementation Plan (Beutler et al., 2005). A considerable number of recent studies concerning relevant Earth system processes and the geodetic observations required to study these processes have been produced. Examples are the UNAVCO report on solid Earth science (UNAVCO, 1998), the German report on mass movements (Ilk et al., 2005), and the U.S. report on InSAR (InSAR Working Group, 2005). In addition to these report, a number of science reports from related fields have been consulted, such as the report on earthquake science by the National Research Council (Board on Earth Sciences and Resources, 2003), the NASA study on a global earthquake satellite system (Raymond et al., 2003), and the National Research Council Decadal Survey (National Research Council, 2007).

Reno, Boston,
March 2009

*Hans-Peter Plag*
*Michael Pearlman*

http://www.springer.com/978-3-642-02686-7

Global Geodetic Observing System
Meeting the Requirements of a Global Society on a Changing Planet in 2020
Plag, H.-P.; Pearlman, M. (Eds.)
2009, XLIV, 332 p., Hardcover
ISBN: 978-3-642-02686-7