

Preface

Methods of satellite geodesy are increasingly used in geodesy, surveying engineering, and related disciplines. In particular, the modern development of precise and operational satellite based positioning and navigation techniques have entered all fields of geosciences and engineering. A growing demand is also evident for fine-structured gravity field models from new and forthcoming satellite missions and for the monitoring of Earth's rotation in space. For many years I have had the feeling that there is a definite need for a systematic textbook covering the whole subject, including both its foundations and its applications. It is my intention that this book should, at least in part, help to fulfill this requirement.

The material presented here is partly based on courses taught at the University of Hannover since 1973 and on guest lectures given abroad. It is my hope that this material can be used at other universities for similar courses. This book is intended to serve as a text for advanced undergraduates and for graduates, mainly in geodesy, surveying engineering, photogrammetry, cartography and geomatics. It is also intended as a source of information for professionals who have an interest in the methods and results of satellite geodesy and who need to acquaint themselves with new developments. In addition, this book is aimed at students, teachers, professionals and scientists from related fields of engineering and geosciences, such as terrestrial and space navigation, hydrography, civil engineering, traffic control, GIS technology, geography, geology, geophysics and oceanography. In line with this objective, the character of the book falls somewhere between that of a textbook and that of a handbook. The background required is an undergraduate level of mathematics and elementary mathematical statistics. Because of rapid and continuous developments in this field, it has been necessary to be selective, and to give greater weight to some topics than to others. Particular importance has been attached to the fundamentals and to the applications, especially to the use of artificial satellites for the determination of precise positions. A comprehensive list of references has been added for further reading to facilitate deeper and advanced studies.

The first edition of this book was published in 1993 as an English translation and update of the book "Satellitengeodäsie", that was printed in the German language in 1989. The present edition has been completely revised and significantly extended. The fundamental structure of the first edition has been maintained to facilitate continuity of teaching; however, outdated material has been removed and new material has been included. All chapters have been updated and some have been re-written. The overall status is autumn 2002 but some of the most recent technological developments to March 2003 have been included.

Extensions and updates mainly pertain to reference coordinate systems and reference frames [2.2], signal propagation [2.3], directions with CCD technology [5.2], the Global Positioning System (GPS) and GNSS [7], satellite laser ranging [8], satellite

altimetry [9], gravity field missions [10] and applications [12]. In particular, the chapter on GPS and GNSS [7] has been almost completely re-written and now covers about 200 pages. Together with chapters [2], [3], and [12], it forms a comprehensive GPS manual on its own. New technological developments of the space and user segment are included, as is the current state of data analysis and error budget. Differential GPS and permanent reference networks are now treated in a comprehensive section of their own [7.5]. GLONASS and the forthcoming GALILEO are included in a new section on GNSS [7.7].

Gravity field missions like CHAMP, GRACE and GOCE, because of their increasing importance, are dealt with in a new chapter [10]. VLBI, together with the new inclusion of interferometric SAR, form another new chapter [11]. Coverage of historical techniques like photographic camera observations [5] and Transit Doppler [6] has been considerably reduced. The basic principles, however, are still included because of their historical importance and because they are shared by new technologies like CCD cameras [5.2] and DORIS [6.7]. The geodetic history of Transit Doppler techniques, in addition, is an excellent source for understanding the evolution and basic concepts of the GPS. The chapter on applications, now renumbered [12], has been updated to include modern developments and a new section on the combination of geodetic space techniques [12.5]. International services of interest to satellite geodesy have been included, namely the IGS [7.8.1], the ILRS [8.5.1], the IVS [11.1.3], and the IERS [12.4].

The bibliography has been updated and expanded considerably by adding an increased number of English language references. The total number of references is now reaching 760, about half of which are new in this edition.

Many of the examples within this book are based on field projects and research work carried out in collaboration with my graduate students, doctorate candidates and scientific colleagues at the University of Hannover over more than 20 years. I would like to thank all these individuals for their long standing cooperation and the many fruitful discussions I have had with them. In addition, the help of the staff at the Institut für Erdmessung is gratefully acknowledged. Most figures have been redrawn by cand. geod. Anke Daubner and Dipl.-Ing. Wolfgang Paech.

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