

# Preface to the Fifth Edition

The origin of this introductory textbook goes back to the booklet “Geodäsie”, prepared by the first author and published in 1975 by Walter de Gruyter and Co. The English translation (1980) was well accepted by the geodetic and surveying community, which led to revised and extended editions in 1991, 2001, and 2012, as well as to translations into Spanish, Chinese, and Greek. Recognizing the continuing interest in the “Geodesy” together with an impressive leap forward in geodetic observing techniques, analysis methods, and a vastly increasing number of users of geodetic products, the publisher and the authors of the fourth edition Wolfgang Torge and Jürgen Müller, both professors at the Institut für Erdmessung (IfE), Leibniz Universität Hannover, decided to prepare a fifth edition and to invite Roland Pail, a professor at the Institute of Astronomical and Physical Geodesy (IAPG), Technical University of Munich, as co-author of the fifth edition. Although it keeps the basic structure of the fourth edition, the contents of several chapters have been restructured, moved to other chapters, or even removed to make place for recent developments in geodesy without exploding the total volume of this textbook. In addition to the eight chapters of the fourth edition, a ninth chapter on challenges and future perspectives in geodesy is adopted. An extensive revision was necessary for almost all chapters, reflecting the increasingly important role that geodesy has achieved in the past decade in providing key geodetic products to be used in daily life, but also within the joint effort of the geosciences at monitoring and interpreting the global change of our planet on all spatial and temporal scales. The Global Geodetic Observing System established by the International Association of Geodesy represents the outstanding example for the geodetic part of this interdisciplinary concert, with an overwhelming contribution of geodetic space techniques.

The “Introduction” again contains the definition and an overview of about 2000 years of the history of geodesy, with the current change to a four-dimensional concept considering also the coupling of space and time as given by Einstein’s theory of general relativity, and strong connections to astronomy, physics, and the other geosciences. The chapter on “Reference Systems and Reference Frames” has been revised thoroughly. It includes the recent definition and realization of celestial and terrestrial reference systems, and emphasizes the fundamental role of Earth’s rotation. The chapter “The Gravity Field of the Earth” was thoroughly revised, partly restructured and extended, for example regarding the topic of heights, taking into account new opportunities of physical height determination and global height unification resulting from modern satellite observing techniques and high-precision clock networks. Only minor changes were necessary in the chapter on “The Geodetic Earth Model”. The chapter on “Measurement Methods” required substantial adaptations, taking into account the impressive progress of geodetic observing techniques during the last decade. Also, novel technology like quantum gravimetry is addressed. The former chapter “Methods of Positioning and Gravity Field Modeling” is now mainly focusing on “Methods of Gravity Field Determination”, while the former contents on geometry

were moved to other chapters. This chapter was also restructured, revised and extended significantly, due to the substantial progress in local, regional and global gravity modeling from various data types. The transition from classical geodetic control networks to three-dimensional reference frames embedded in the global terrestrial reference system is treated in the chapter on “Geodetic and Gravimetric Networks”, where the developments of the past 10 years are reflected in the new edition. The chapter “Structure and Dynamics of the Earth” had to be extended significantly, in order to adequately consider the geodetic contribution to the investigation and modeling of geodynamic processes of global to local scale, especially taking into account the value of satellite gravity missions and space geodetic techniques. Correspondingly, several sections have been(re-)written from scratch, in order to reflect the present state of research, which is shown by several case studies, referring to, e.g., continental hydrology, ice mass melting, sea level change, glacial isostatic adjustment, plate tectonics, seismic and volcanic activity and Earth tides. The newly adopted chapter “Geodesy – challenges and future perspectives” can be considered as a roadmap towards a sustained geodetic observing system.

The text is illustrated by numerous figures, either depicting fundamental relations or showing geodetic techniques, reference systems, gravity field models, and examples of geodynamics research. The book’s revision led to a volume increase of about 10 %, and numerous figures were replaced or newly included. The list of references is largely updated.

The book especially addresses graduate students in the fields of geodesy, geophysics, surveying engineering, and geomatics, as well as students of terrestrial and space navigation. It should also serve as a reference for geoscientists and engineers facing geodetic problems in their professional work.

The contents of the book are partly based on lectures given by the authors at the Leibniz Universität Hannover, the Technical University of Munich, Germany, and on guest lectures given abroad. The authors are indebted to individuals and institutions for providing illustrations, due credit is given in the figure captions. Several colleagues provided valuable input to this new edition or supported us in prove-reading and upgrading the corresponding sections, namely Prof. Steffen Schön, Dr. Manuel Schilling, Vishwa Singh, Dr. Ludger Timmen (Institut für Erdmessung, Leibniz Universität Hannover), Dr. Detlef Angermann and Dr. Denise Dettmering (Technische Universität München), Dr. Cord-Hinrich Jahn (LGLN, Hannover). Special thanks go to Mareike Brekenkamp, B.Sc. for her highly valuable assistance in preparing chapter 1, proof-reading parts of the text and indexing the whole manuscript. The good cooperation with the publisher, proven over nearly 40 years association, continued, cordial thanks go to Kristin Berber-Nerlinger, Ute Skambraks, and the staff at De Gruyter.

Last but not least, we would like to dedicate this fifth editor to our colleague, teacher and friend Prof. Helmut Moritz, who influenced our scientific careers in very different, but throughout positive ways. He passed away just a few days before the submission of the manuscript of this fifth edition. We know that he was truly fascinated

about the developments of modern geodesy until the very end, and we hope that he would have been happy about the contents of this edition, which is published 56 years after his fundamental and pioneering textbook “Physical Geodesy”.

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