Preface

This textbook provides a comprehensive overview of gravity integration and inversion, which contributes to physical geodesy and geophysics, and it identifies classical and modern topics for studying the Earth. It discusses both theoretical and practical aspects, e.g., for the determination of a precise geoid model besides presenting ample worked examples. Physical geodesy terminology is used throughout the book. The unprecedented knowledge of the Earth's gravity field and its temporal variation are progressively capturing the attention of the geosciences for many reasons. As a result of recent dedicated satellite missions, knowledge of the global to regional gravity field has reached extraordinary levels of quality and resolution. The modeling of the Earth's mass distributions in the crust and its interior, as well as the temporal changes/transports of such masses, is most important in studying geodynamics. The enhanced knowledge of the 3D-layered structure of the Earth will improve our capability to understand, monitor and predict geophysical processes, which potentially threaten our technically developed society. Today, thanks to the development of atomic clocks, the original idea of A. Bjerhammar from 1975 of chronometric leveling for direct measurement of geopotential differences is emerging as a fascinating new tool in geodetic and geophysical applications.

The aim of this book is to provide students at the M.Sc and Ph.D. levels, as well as researchers, basic and some in-depth knowledge about the current and recent theory and application of gravity for geodesy and geophysics, as seen mainly from a geodesist's perspective and with an emphasize on theory. Physical geodesy is treated rather generally, and a main goal is to provide the reader with a theory (the KTH method) for determining "the 1-cm geoid" (including both geoid and quasigeoid methods), while the geophysical applications of gravity are limited to the determination of crustal depth and density contrast at the crust/mantle boundary, and stress and viscosity in the upper mantle, as well as some simple examples of how to estimate the mass and depth of some other large-mass structures in the Earth from combinations of the geopotential, gravity, and gravity gradients. Temporal changes of the gravity field are treated with emphasis on long-term trends, while periodic changes are more sparsely utilized.

Another motivation behind this book is, to honour the centennial anniversary of, and, to some extent, announce and revive some research ideas originating with the deceased A. Bjerhammar (1917–2011) at the Royal Institute of Technology (KTH) in Stockholm, Sweden. Bjerhammar is well-known for his research in physical geodesy and geodetic studies on the Fennoscandia land-uplift phenomenon and its relation to the regional gravity field and upper mantle viscosity in the region, as well as for being a pioneer in developing a theory for linear adjustment of erroneous observations using generalized matrix algebra. Unfortunately, much of his research can only be found in disparate papers presented in various journals, at conferences and as internal reports from KTH. As the first author of this book has been a M.Sc and Ph.D. student of Bjerhammart from 1969 to 1975, his co-worker until 1980, and his successor since 1984, this book to some extent sought to reflect and further continue his research ideas, as well as on other ideas developed and partly published in papers, etc.

The second author was a Ph.D. student at KTH during 2007–2011 and a postdoc 2011–2014, with the prime author as his supervisor on the determination of the crustal depth and density contrast from Earth gravitational models using an isostatic model as a specialty in his research. He currently performs multidisciplinary research and is active in several directions, such as in geophysics, geodesy and land surveying (applied geodesy). His main research interest is to develop and study relations between geodesy and geophysics especially study on temporal changes of the Earth's gravity field and glacial isostatic adjustment.

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