# International Association of Geodesy Symposia

*Ivan I. Mueller, Series Editor*

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*Symposium 109:* Permanent Satellite Tracking Networks for Geodesy and Geodynamics
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# From Mars to Greenland: Charting Gravity With Space and Airborne Instruments

## Fields, Tides, Methods, Results

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# Preface

This is the book of proceedings of the Symposium on the Determination of the Gravity Field by Space and Airborne Methods, sponsored by the International Association of Geodesy (IAG). That meeting took place in Vienna, on August 20, 1991, as part of the XX General Assembly of the IUGG. Included are those articles describing work presented at the meeting, written in accordance to the guidelines that were received by November 30, 1991. The papers were all submitted by their authors in camera-ready form. Their editing has been limited to a check of overall technical fitness and relevance, without looking into the validity of every detail. Some 75% of the works originally listed in the Symposium's program, oral and poster, appear in this book. Several individuals and organizations have contributed directly, with their effort or support, to the success of this enterprise. In particular, I wish to thank my Symposium co-convenors, Professors Klaus-Peter Schwarz and Reiner Rummel, for taking the initiative within the IAG from the very beginning, and keeping open the way for this multi-section gathering to take place. My appreciation also to M. Louis, Secretary General of the IAG, for facilitating communications within the IAG and with the Austrian organizers. Finally, many thanks to my colleagues at NASA Goddard Space Flight Center for letting me have the necessary time and the physical means to carry out several organizing and editorial tasks.

The mapping of the gravity field of the Earth and planets has come a long way since the start of the Space Age, in late 1957. Satellites have been used as probes to detect, on a global basis, the departures of the actual field from that of a simple reference ellipsoid. That information has been extracted, mostly, from tracking data that reveal irregularities in the orbits caused by the uneven pull of the gravity being charted. In general, the resolution of the picture thus obtained increases with decreasing height. In more recent times, the idea of measuring microgravity with very sensitive accelerometers has been at the heart of plans to place gravity gradiometers in very low orbits, to detect finer details than by conventional spacecraft tracking. The use of the ubiquitous Global Positioning System to find the trajectories of spacecraft and other vehicles is having a deep effect on gravity work. The possibility of tracking an airplane with great precision in this way, to determine its acceleration in order to correct the reading of an onboard gravimeter, is opening the way for the relatively inexpensive and fast survey of large areas, with a few kilometers' resolution, at the mgal level. A further development of this idea is to combine the GPS with a very precise inertial navigation system to recover the full gravity vector and, thus, measure deflections of the vertical as well as gravity anomalies. Satellite altimetry, combined with precise orbit determination, has allowed the very detailed mapping of the field over the oceans (ocean geoid), and the long-sought separation there of geostrophic current effects from gravity anomalies. Nearly 20 years of continuous use of satellite laser ranging has yielded a data set unique in homogeneity and length of temporal coverage, now being used to answer questions about long-period tides and other causes of change in gravity.

The purpose of this Symposium has been to bring together those working in the areas just outlined, so as to give a composite picture of both goals reached and directions taken in the remote sensing of gravity, at the beginning of the last decade of this millennium. The works published here have been ordered to reveal the sweep of current activities: from global pictures of the fields of Mars, Earth, and Venus, to the detailed survey of Greenland by aircraft, the largest ever attempted anywhere thus

far. Some of the papers, like those dealing with the latest global maps of the Earth's field, represent the culmination of decades of international efforts. Others, like the one partly written in a computer, on an airplane, during an aerial survey, suggest the new possibilities that recent technical advances in many areas (computing, instrumentation, data analysis, space systems, and so on) are offering to those still going out in the old and endless quest to know, better and better, the curious shape of our changing world.

*Oscar L. Colombo*
*Greenbelt, Maryland, December of 1991*

# Contents

**Airborne Techniques II: New Directions**



**Related Theory**