Foreword to the Special Issue on TerraSAR-X: Mission, Calibration, and First Results

TerraSAR-X is Germany’s first civil radar satellite. It has been realized in a public–private partnership between the German Aerospace Center (DLR) and EADS Astrium GmbH. The high-resolution synthetic aperture radar (SAR) satellite, which was successfully launched on June 15, 2007, delivers high-quality radar images for scientific and commercial applications. TerraSAR-X is the fruit of consistent development of German radar technology over many years and is an example of successful cooperation between the DLR and the German space industry. More than 45,000 data sets have been acquired and processed since the launch of the satellite. The image product quality is exceeding all specifications and setting new standards for future spaceborne SAR missions. The high stability of the sensor, the high precision of the calibration, the demonstration of new imaging modes, and the outstanding geolocation accuracy of the images are examples of highlights already achieved with TerraSAR-X during the commissioning phase.

In this last decade, more than 15 SAR satellites have successfully been launched for scientific, commercial, and security-related applications. SAR is an indispensable source of information in Earth observation since spaceborne SAR is the only imaging sensor that has all-weather and day-and-night high-resolution imaging capability. SAR already plays a major role in a wide spectrum of applications for 2-D, 3-D, and 4-D (space-time) mapping, environmental monitoring, retrieval of bio/geophysical parameters of land, ocean, and ice surfaces, hazard and disaster monitoring, and reconnaissance and security-related applications. Information extraction has achieved a mature and operational level in a number of fields, making the contributions of SAR systems to present and future programs like GMES and GEOSS an indispensable one.

In the last few years, we have entered a new era of spaceborne SAR systems. New satellites like TerraSAR-X, COSMO-Skymed, Radarsat-2, TanDEM-X, and Sentinel-1 provide or will provide radar images with a resolution up to 100 times better than the one of conventional SAR systems. They are also outperforming by far existing systems with respect to their imaging flexibility and interferometric modes. These SAR satellites open new fields for scientific use of radar data. A golden age for spaceborne SAR systems has just started.

The objective of this Special Issue is to give an overview of the TerraSAR-X mission, commissioning phase, calibration, data processing, and applications. Several examples of application results achieved by the international science community are presented. You will find some “firsts” related to technology demonstration, product and processing accuracy, as well as applications. Indeed, the TerraSAR-X mission started in the very beginning with a highlight: the first images were already processed 4.6 days after launch in a fully automatic way. After 2.5 years of operation, no degradation of the instrument performance could be observed at all. TerraSAR-X will be accompanied by a second almost identical satellite from 2010 onward. TanDEM-X will fly in close formation with TerraSAR-X for approximately three years and will operate as a bistatic radar interferometer. The primary objective of the TanDEM-X mission is the generation of a consistent global digital elevation model with unprecedented accuracy. Beyond that, TanDEM-X will provide a highly reconfigurable platform for the demonstration of new radar imaging techniques and applications.

From the Call for Papers for this Special Issue, we obtained an excellent resonance with a total of 55 papers submitted. As a result of a careful review process, 34 papers have been accepted for publication. We hope that experts in the SAR field will find much interesting information in this issue and that newcomers to the SAR field are able to learn many aspects of SAR technology, techniques, and applications.

We would like to thank all the reviewers for their time and dedication to the review process. The Guest Editors are also very grateful to Prof. Chris Ruf, Editor of IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, for his encouragement and support in preparing this Special Issue.

ALBERTO MOREIRA, Guest Editor
Microwaves and Radar Institute,
German Aerospace Center (DLR)
82230 Oberpfaffenhofen, Germany

RICHARD BAMLER, Guest Editor
Remote Sensing Technology Institute,
German Aerospace Center (DLR)
82230 Oberpfaffenhofen, Germany

Digital Object Identifier 10.1109/TGRS.2009.2039830
Alberto Moreira (M’92–S’96–F’04) was born in São José dos Campos, Brazil, in 1962. He received the B.S.E.E. and M.S.E.E. degrees from the Aeronautical Technological Institute (ITA), São José dos Campos, in 1984 and 1986, respectively, and the Eng.Dr. degree (with honors) from the Technical University of Munich, Germany, in 1993.

From 1996 to 2001, he was the Chief Scientist and Engineer with the SAR Technology Department, Microwaves and Radar Institute, German Aerospace Center (DLR), Oberpfaffenhofen, Germany, where since 2001, he has been the Director of the Microwaves and Radar Institute. The institute contributes to several scientific programs and space projects for actual and future airborne and spaceborne SAR missions like TerraSAR-X and Sentinel-1. Since 2003, he has been a Full Professor with the University of Karlsruhe, Germany, in the field of microwave remote sensing. In 2006, the mission proposal TanDEM-X led by his institute has been approved for the realization phase. He is the Principal Investigator for this mission. Under his leadership, the DLR airborne SAR system, i.e., E-SAR, has been upgraded to operate in innovative imaging modes like polarimetric SAR interferometry and SAR tomography. He has more than 250 publications in international conferences and journals. He is the holder of 15 patents in the radar and antenna field. His professional interests and research areas encompass radar end-to-end system design and analysis, innovative microwave techniques and system concepts, signal processing, and remote-sensing applications.

Prof. Moreira is a member of the IEEE Geoscience and Remote Sensing Society (GRS-S) Administrative Committee (1999–2001, 2004–2009, 2008–2010 as Executive Vice-President), was the Founder and Chair of the German Chapter of the GRS-S (2003–2008), was an Associate Editor for the IEEE GEOSCIENCE AND REMOTE SENSING LETTERS (2003–2007), and has been serving as an Associate and Guest Editor for the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING since 2005. In 1995, he received the DLR Science Award. He and his colleagues received the GRS-S Transactions Prize Paper Awards in 1997, 2001, and 2007. He also received the IEEE Nathanson Award for the Young Radar Engineer of the Year in 1999 and the IEEE Kiyo Tomiyasu Field Award in 2007. From 2003 until 2008, he served as a member of the Board of Directors of the Information Technology Society of the German Association for Electrical, Electronic and Information Technologies and is currently Chair of the Scientific and Technical Council of the German Aerospace Center (2009–2011). He has participated in 19 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) conferences. He has contributed to the successful series of the European SAR conferences (EUSAR) since 1996 as a member of the Technical Program Committee, the Technical Chairman (2000), the Awards Chairman (2002–2004), the General Chairman (2006), and the Co-Chairman (2008).

Richard Bamler (M’95–SM’00–F’05) received the Diploma degree in electrical engineering, the Dr.Eng. degree, and the “Habilitation” degree in signal and systems theory from the Technische Universität München, Munich, Germany, in 1980, 1986, and 1988, respectively.

In 1981 and 1989, he was with the Technische Universität München, working on optical signal processing, holography, wave propagation, and tomography. Since 1989, he has been with the German Aerospace Center (DLR), Oberpfaffenhofen, Germany, where he is currently the Director of the Remote Sensing Technology Institute. Since then, he and his team have been working on synthetic aperture radar (SAR) signal processing algorithms (ERS, SIR-C/X-SAR, Radarsat, SRTM, ASAR, TerraSAR-X, and TanDEM-X), SAR calibration and product validation, SAR interferometry, phase unwrapping, estimation theory, and model-based inversion methods for atmospheric sounding (GOME, SCIAMACHY, MIPAS, and GOME-2), oceanography, and 3-D optical remote sensing. In 1994, he was a Visiting Scientist with the Jet Propulsion Laboratory, Pasadena, CA, in preparation for the SIC-C/X-SAR missions, and in 1996, he was a Guest Professor with the University of Innsbruck, Austria. Since 2003, he has been holding a Professorship in remote sensing technology with the Technische Universität München. He and his team have recently developed the processor system for TerraSAR-X and are currently developing the processors for TanDEM-X and EnMAP. He is the author of more than 160 scientific publications, among them about 40 journal papers and a book on multidimensional linear systems theory. He is the holder of several patents on SAR signal processing. His current research interests are in algorithms for optimum information extraction from remote sensing data with emphasis on SAR, SAR interferometry, persistent scatterer interferometry, SAR tomography, and GMTI for traffic monitoring.

Dr. Bamler served as the Technical Program Chairman of the IEEE International Geoscience and Remote Sensing Symposium (IGARSS) in 1999 and was the Guest Editor of the Special IGARSS’99 Issue of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING.