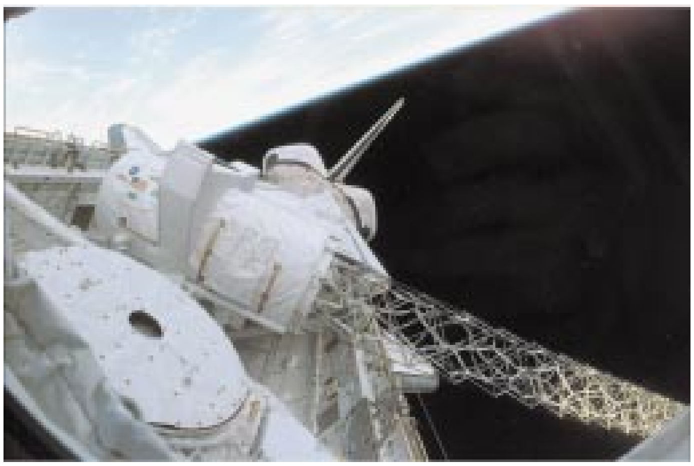
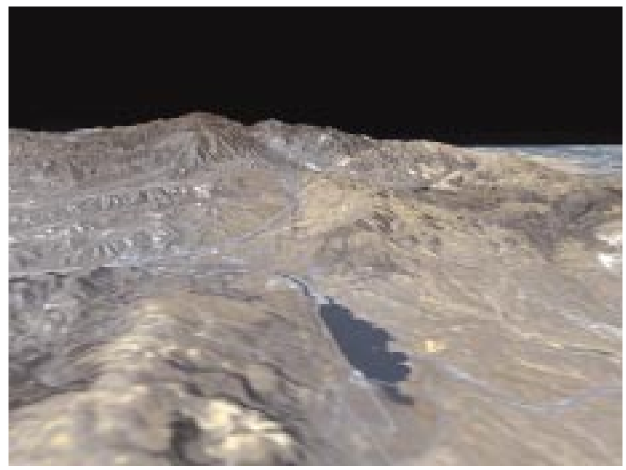
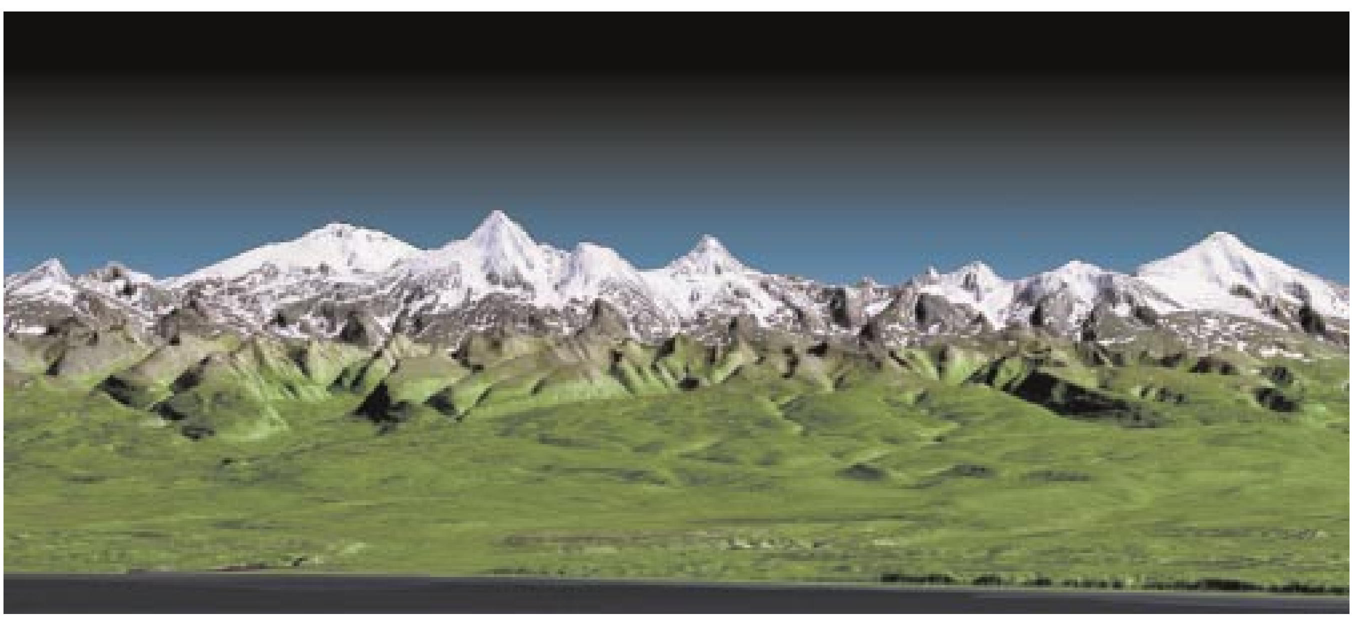
GEOSCIENCE *and* REMOTE SENSING

Newsletter

Editor: Steven C. Reising







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Newsletter Input and Deadlines

The following is the schedule for the GRSS Newsletter. If you would like to contribute an article, please submit your input according to this schedule. Input is preferred in Microsoft Word, WordPerfect or ASCII for IBM format (please send disk and hard copy) as IEEE now uses electronic publishing. Other word processing formats, including those for Macintosh, are also acceptable, however, please be sure to identify the format on the disk and include the hard copy.

GRSS Newsletter Schedule

Month	March	June	Sept	Dec
Input	Jan 15	April 15	July 15	Oct 15

IEEE GRSS AdCom, Officers and Committee Chairs - 2000 GRS-29 (Division IX)

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Greetings to all members of the Geoscience and Remote Sensing Society. I begin as Editor of our Newsletter with this issue. I would first like to thank the GRSS AdCom and the membership as a whole for entrusting me with the duties and responsibilities of this position. I anticipate that the Newsletter will continue to serve as an active forum for both technical and informal communication among our members.

The outgoing Newsletter Editor is Professor Christopher S. Ruf. Chris began this service to our Society with the March 1997 issue, and he deserves our gratitude for his time and effort. During his three-year term as Editor, the Newsletter has gained an attractive color cover, with a new masthead and relevant remote sensing images, as well as added a Newsletter web page, now consolidated with the GRSS web page, and accessible at *http://ewh.ieee.org/soc/grss/newsletter/grssnewshome.html*. During the transition of the editorship in recent months, Chris has provided information and assistance to ease me into the position. Please join me in thanking Chris Ruf for his service to our Society.

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President's Message

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In mid-February 2000 the IGARSS 2000 Technical Program Committee selected the submitted papers for presentation in the various oral and poster sessions at the IGARSS 2000 Symposium. Many of you supported this activity by reviewing quite a number of papers. In total approximately 1,600 papers were submitted, more than for any previous IGARSS. From the titles alone it is evident that Remote Sensing is still a young science. New technologies, techniques and systems with exciting features will be presented at IGARSS in Honolulu. The theme for this year is Taking the Pulse of the Planet: The Role of Remote Sensing in Managing the Global Environment. Our responsibility for the future of our planet and for humanity is evident. We are the ones who need to make decisionmakers and politicians aware of environmental development issues, present and future. Our results have to be timely and precise, with global coverage from subsurface to space. This is our challenge for the future.

Numerous items were discussed at the IEEE Technical Activity Board (TAB) and Board of Directors (BoD) meetings in New Orleans in mid-February. It seems that the financial problems have been solved. There is an ongoing discussion about our logo and trademark. A new position statement is another issue. Further streamlining the administration is also one of the hot topics. However, what seems to me of utmost interest to the members is electronic publishing. This will become a multimillion-dollar market in the future. Each entity will try to establish intellectual property for its products. The fight for the market started vehemently in 1999. The big publishers like Elsevier and Bertelsmann are like dinosaurs in this business. In the past, IEEE had difficulties to keep up. But it seems that with its elec-

Cover Figure Information

Top left: Part of the Shuttle Radar Topography Mission hardware is photographed through Endeavour's aft flight deck windows about half way through the scheduled 11-day SRTM flight. The mast, only partially visible at lower right, is actually 200 feet (60 meters) in length.

Top right: The prominent linear feature straight down the center of this perspective view is the San Andreas Fault. The SRTM C-band interferometric SAR data used to create this image will enhance detailed studies of fault dynamics and landforms resulting from active tectonics. This segment of the fault lies west of the city of Palmdale, California, about 100 kilometers northwest of Los Angeles.

Bottom: This perspective view shows the western side of the volcanically active Kamchatka Peninsula in eastern Russia. The image was generated using the first data collected from the C-band instrument during SRTM. In the foreground is the Sea of Okhotsk. Inland from the coast, vegetated floodplains and low relief hills rise toward snow capped peaks. High-resolution SRTM topographic data will be used by geologists to study how volcanoes form and to understand the hazards posed by future eruptions.

Photo Credit: NASA/JPL/Caltech

President's Message

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tronic publishing systems, AKS, IEL and Xplore, IEEE has achieved an excellent entry into the market. As a member you have access to products of your Society without cost. For other Societies to which you do not belong, there is a low fee for electronic products. Nonmembers are required to pay the full fee, which may be between $15 and $25 (US) per paper order. I recommend that you "Xplore" the web (*www .ieee.org.ieeexplore*) and see what is available. When Xplore was first launched on February, 29th, 2000, I was impressed. The quality of most of our publications is excellent. Meanwhile several other Societies have already published digitally on CD-ROMs or DVDs. Our Society will go completely digital during 2001.

At the AdCom meeting the Technical Committee Chairmen presented their respective Committee activities. Dave deBoer reported on the Instrumentation and Future Techologies Committee, Larry Fishtaler the Data Standardization and Distribution Technical Committee and Paul Smits the Data Fusion Committee. If you are interested in one or more of these committees and their work please contact the Chairman directly. You can access the home page of these committees through the IEEE home page, under Societies. Several IEEE Societies have formed the new IEEE Sensor Council. Our GRS-Society is represented by Al Gasiewski and Andy Blanchard. During recent meetings the new Council decided to publish an IEEE Sensor Journal, with the first issue expected by May 2001. GRS-S is also active in the IEEE New Technology Direction Committee, and Paul Racette is our representative. In 2002 the hardcopy of our GRS-S Transactions will become optional. TGARS will go to twelve issues per year, starting in 2001.

A major point of discussion at the AdCom meeting was the extension of GRS-S activities in publications, conferences, and workshops. The decision was made to examine the possibility of rapid publishing of letters, as is done by several other Societies (e.g.. MTT). It was also decided to increase the number of workshops and conferences supported or sponsored by GRS-S. Two workshops are already being organized. I would like to ask all members to think about workshops in their area of specialization. These workshops are usually dedicated to a single topic and may have several tens up to more than one hundred participants.

We now look all forward to IGARSS 2000 in Hawaii. I look forward to meeting all of you at the reception on Sunday evening, July 23rd. Ned Sauthoff, President of IEEE USA, will speak briefly. Take the opportunity, go global, come to Hawaii!

Werner Wiesbeck
President IEEE GRS-S

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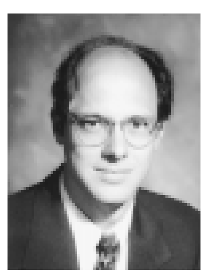

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Introducing the New AdCom Members for 2000

Jon Atli Benediktsson is Professor of Electrical and Computer Engineering at the University of Iceland, Reykjavik, and a Visiting Professor at the School of Computer Science and Electronic Systems, Kingston University, Kingston upon Thames, U.K. He received the Ph.D. degree from the School of Electrical Engineering at Purdue University in 1990 and also received the 1991 Stevan J. Kristof Award as the outstanding graduate student in remote sensing. He was the recipient of the 1997 Icelandic Research Council's Outstanding Young Researcher Award and was recently selected as a recipient of the IEEE Third Millenium Medal. Dr. Benediktsson is currently an Associate Editor of the IEEE Transactions on Geoscience and Remote Sensing (TGARS). From 1996 to 1999 he served as the Chairman of the IEEE Geoscience and Remote Sensing Society's Technical Committee on Data Fusion. He co-edited (with Professor David A. Landgrebe) a Special Issue on Data Fusion of TGARS which appeared in May of 1999. He has held visiting positions at the Joint Research Centre of the European Commission, Ispra, Italy, at Denmark's Technical University (DTU), Lyngby, Denmark, and at the School of Electrical and Computer Engineering, Purdue University. His research interests are in pattern recognition, neural networks, remote sensing, image processing, and signal processing, and he has published extensively in those fields.

Alberto Moreira (M'92, S'96) was born in São José dos Campos, Brazil, in 1962. He received the B.S.E.E. and the M.S.E.E. degrees, in 1984 and 1986, respectively, from the Aeronautical Technological Institute (ITA), Brazil and the Eng. Dr. degree (*mit Auszeichnung* - Honors) from the Technical University of Munich, Germany, in 1993.

From 1985 to 1986, he worked at ITA as a research assistant and consultant. In 1987 he received a four year scholarship from DAAD, Germany to work towards his Ph.D. at the German Aerospace Center (DLR - Institut für Hochfrequenztechnik) in the area of SAR signal processing. From 1992 to 1995, he was the head of the Signal Processing Group at DLR. As its chief scientist and engineer since 1996, Dr. Moreira manages the DLR SAR Technology Department. He is responsible for developing and operating the high-resolution DLR airborne SAR system. Under his leadership, the DLR airborne SAR system has been upgraded to operate in innovative imaging modes like polarimetric SAR interferometry and polarimetric tomography.

In 1995 Dr. Moreira was the recipient of the DLR Science Award. In 1996 he and his colleagues received the IEEE 1996 Transactions Prize Paper Award for the development of the so-called "Extended Chirp Scaling Algorithm." In 1999 he received the IEEE AESS Fred Nathanson Memorial Radar Award to the Young Engineer of the Year. Dr. Moreira's professional interests and research areas encompass SAR end-to-end system design and analysis, SAR signal processing, polarimetry and interferometry, innovative radar techniques and expert systems for data fusion and classification.

David E. Weissman (S'60-M'61-SM'76-F'91) received his B.A. and B.E.E. degrees in 1960 and his M.E.E. degree in 1961 from New York University, and his Ph.D. degree in Electrical Engineering from Stanford University in 1968. From 1963-1968 he was a Research Engineer for Stanford Research Institute, Menlo Park, CA. Since 1968 Professor Weissman has been a full-time faculty member at Hofstra University. His research over the past 30 years has involved the development of microwave radar remote sensing techniques that can estimate ocean surface winds and atmospheric turbulence structure parameters. These results will enable scientific applications for satellite-based radars (NSCAT and QuikScat; for the measurement of global ocean wind fields and stress) and for the measurement of air-sea interaction on the microscale and mesoscale levels.

His service to the IEEE spans 24 years. He was Editor-in-Chief of the IEEE Journal of Oceanic Engineering from 1979-1982, Conference Technical Committee Co-Chairman for the 1983 IEEE Geoscience and Remote Sensing Society Symposium, and a member of the IEEE Publications board,

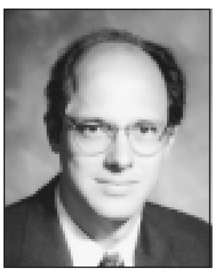
1988-1989. He has been member of the Administrative Committee of the Oceanic Engineering Society (OES) since 1976, Chairman of the Technical Committee on Remote Sensing, OES, since 1985, and is currently Chairman of the OES Fellow Evaluation Committee. He was elected to the GRS ADCOM in 1999.

Prof. Weissman was elected IEEE Fellow in December 1990. He received the IEEE Centennial Medal in 1984, (nominated by the Oceanic Engineering Society). He received the Best Applications Paper Award in 1977 for a paper co-authored with James W. Johnson and published in the IEEE Transactions on Antennas and Propagation. In 1995, he was honored with the Oceanic Engineering Society Distinguished Service Award. He received a NASA HQ Citation for contributions to the NSCAT Scatterometer Project in 1998.

Introducing New Associate Editor for Organizational Profiles

Edward J. Kim (S'90, M'99) received the SB, SM, and Engineer's degrees all in Electrical Engineering from the Massachusetts Institute of Technology. He completed a joint PhD with the Departments of Electrical Engineering and Atmospheric Sciences at the University of Michigan in 1998. From 1987 to 1998, he was also a self-employed engineering consultant. At MIT, he worked on ground-based and spaceborne optical interferometry projects for astronomy. At Michigan, he worked with one of the first land surface process models coupled to a soil/vegetation microwave emission model. He also built a suite of microwave radiometers that have been used in three ground experiments totaling 500 deployed days. In 1997, he was selected for a National Research Council Research Associateship, and in 1998, he was awarded second prize in the International Geoscience & Remote Sensing Symposium student paper competition. Dr. Kim is now at NASA's Goddard Space Flight Center, where he works with the Microwave Sensors and Hydrological Sciences Branches. His interests include the modeling of soil, vegetation, and snow; radiative transfer theory; and instrument development. At Goddard, he is Principal Investigator for the Airborne C-band Microwave Radiometer.

Introducing New Associate Editor for University Profiles



Stephen J. Frasier (S`94-M`95) received the B.E.E. degree in 1987 from the University of Delaware and the Ph.D. degree in 1994 from the University of Massachusetts, Amherst.

From 1987 to 1990 he was with SciTec, Inc., a subsidiary of TRW, where he worked on signal processing and analysis of EM and IR signatures of rocket plumes, evaluation of laser detection systems, and development of data acquisition systems for airborne IR sensors. In August 1990 he joined the Microwave Remote Sensing Laboratory of the University of Massachusetts. His graduate work involved the development and application of a phased-array imaging radar for oceanographic research.

Since 1994, Dr. Frasier has been employed by the University of Massachusetts as a Research Engineer, Senior Research Fellow, and currently as Assistant Professor. His research interests include microwave imaging and interferometric techniques, radio oceanography, and boundary-layer remote sensing. Dr. Frasier has served as Chair of the Springfield (MA) chapter of GRSS, and is currently a Commission F representative to the US National Committee, URSI. He is a member of the American Meteorological Society and the American Geophysical Union.

Editor's Comments

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The Editorial Board of the Newsletter has had several personnel changes. The new board members are Edward Kim, Assoc. Editor for Organizational Profiles, and Stephen Frasier, Assoc. Editor for University Profiles. Adriano Camps continues to serve as Assoc. Editor for European Affairs. I encourage anyone interested in submitting articles, comments, upcoming meeting announcements, or letters of interest to our members to contact the appropriate Assoc. Editor or me directly. Contact information and brief biographies of the new members appear later in this issue.

A number of other items of interest appear in this issue. First, as we celebrate the 20th anniversary of GRSS, Keith R. Carver has written an informative and entertaining history of GRSS, beginning with the formation of our Society's predecessor, the Group on Geoscience Electronics (G-GE), in 1961. Next, Christian Mätzler and colleagues at the Helsinki University of Technology have provided a review article on modeling the microwave emission of snowpacks. Our Society President, Werner Wiesbeck, helps our members look toward the future of radar sensors by focusing on the synthesis of RF, microwave, digital and software technologies. In another article he explains the structure of our Society's AdCom, and three new AdCom members are introduced. We are proud to announce that 11 members of our Society were elected as new Fellows of the IEEE for 2000. Finally, the President's Message addresses the current topics of electronic publishing, technical committees, and new workshops, inviting us to go global. As he does, I look forward to seeing you at IGARSS in Hawaii.

History of the IEEE Geoscience and Remote Sensing Society

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Introduction

In this millenium year 2000 we celebrate the 20th anniversary of the formation of the IEEE Geoscience and Remote Sensing Society (GRSS), which evolved in 1980 from the former IEEE Professional Technical Group on Geoscience Electronics (G-GE). G-GE was formed in 1961 as the 29th technical group of the Institute of Radio Engineers (IRE). Over the past two decades GRSS has grown in size and intensity while maturing in technical scope and international stature. As we mark these achievements it is important to remember our earlier roots in G-GE and its evolution to GRSS.

This GRSS history is a chronicle of the vision and achievements of key leaders, and of the sustained professional contributions by many hundreds of scientists and engineers sharing a common interest in geoscientific exploration of the earth, instrumentation, and remote sensing. It also links to their personal lives, their families, and to their employers who have supported the grand endeavors of geoscience and remote sensing. Those who have made these sustained contributions to GRSS are really quite remarkable people. What makes them tick? What drives their engines of such extraordinary professional service?

The first published history of G-GE and GRSS was authored by Ed Wolff and published in the 1991 GRSS Newsletter. I updated this history five years ago and published it in the September 1996 Newsletter as a text-only condensation of a more extensive website version accessible at *http://ewh.ieee.org/soc/grss/history/histindex.html*.

Group on Geoscience Electronics

Formation of G-GE The idea of forming the Group on Geoscience Electronics originated from a 1961 breakfast meeting of twenty interested people convened by Dr. Lloyd V. Berkner, then President of both the IRE and the AGU, and Mr. Robert W. Olson, Vice President of Texas Instruments[1]. This meeting was held on April 20, 1961 at the Southwest IRE Conference in Dallas, Texas and resulted in a petition to the IRE Board of Directors to form a Professional Group on Geoscience Electronics[2]. This petition was approved by the IRE on November 15, 1961.

Robert W. Olson Founder and First Chairman, G-GE

Much of the interest in this organization came from engineers and scientists in the Southwestern United States, primarily those involved in the petroleum industry. Although the early interest was mainly in electro-seismic instrumentation, signal processing and seismic modeling, the G-GE early charter included a much broader range of geophysical and geoscientific topics. The G-GE organized sessions on geoscience electronics topics for the annual Southwest IRE Conference (SWIRECO), beginning in 1962. Sessions and papers were also organized for other meetings including the International IEEE Convention in New York City. These sessions continued until the late 1960's.

Although the first papers presented and published under sponsorship of this society were primarily motivated by electronic instrumentation for petroleum exploration, a concerted effort was begun in 1962 to broaden the scope, particularly by involving oceanographers and others interested in undersea technology and instrumentation.

G-GE AdCom Robert Olson called for a meeting to be held February 15, 1962 in Dallas, the main purpose of which was to organize an Administrative Committee (AdCom) for the Group. There were twenty-one people in attendance at that meeting and an AdCom of nine members was elected: Robert W. Olson and Bernard H. List of Dallas; Marian A. Arthur, Sidney Kaufman and Frank C. Smith of Houston; W. Theodore Girn and Robert A. Broding of Tulsa; W. Harold Mayne of San Antonio; and Harold W. Smith of Austin. The purpose of the AdCom was to provide management of the Group, including financial planning, membership recruitment, oversight of the Transactions and selection of its Editor, and the setting of technical directions.

The first G-GE AdCom meeting was held on April 13, 1962 at the SWIRECO meeting in Houston. This meeting resulted in the election of Bob Olson as the first G-GE AdCom Chairman, and additional AdCom members were added: Ben S. Melton, A. H. Waynich and Jean Lebel. A draft Constitution and Bylaws were discussed and procedures were adopted for mail ballot approval of the final documents. These documents were officially approved by the IRE Executive Committee on October 16, 1962.

A second AdCom meeting was held at the SWIRECO in Dallas on October 1, 1962 and was primarily concerned with

[1] private communication, Prof. Harold W. Smith, University of Texas at Austin, 12-7-95

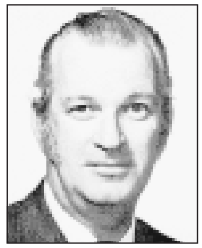
[2] The History of the Geoscience and Remote Sensing Society of the IEEE, Edward A. Wolff, 1991 GRSS Newsletter, pp. 14 - 17.

future activities and a first Group budget. Bob Olson was succeeded by Professor Harold W. Smith, with the Department of Electrical Engineering at the University of Texas, Austin. Other members of the 1963 AdCom included R. A. Broding, T. Cantwell, W. E. Gordon, Isadore "Is" Katz, S. Kaufman, Jean D. Lebel, Bernard H. List, C. Gordon LittleBen S. Melton, Edwin B. Neitzel, Robert W. Olson, F. C. Smith Jr, G. H. Sutton, Aubra E. Tilley, and A. H. Waynich. The Editor of the G-GE Transactions was Alan W. Trorey who was with the California Research Corporation in La Habra. The Newsletter Editor was Edwin B. Neitzel. A copy of the 1964 IEEE Transactions on Geoscience Electronics could be purchased for $2.25, and the annual member subscription price was $12.75.

Table 1 lists the AdCom officers for the period 1962 – 1979.

First Transactions G-GE In 1963 and 1964 the Group on Geoscience Electronics was comprised mainly of U.S. engineers and scientists who were interested in such solid-earth topics as seismic exploration and recording, electroseismic effects, seismometer designs and enhanced filtering techniques applied to seismic signals. The Transactions on Geoscience Electronics (T-GE), first published in December 1963, was concerned with the publication of both theoretical and applied papers on geoscience electronics. Papers were sought that did not have a ready outlet in existing geophysical or engineering journals. Paper submissions were few in this new journal, with four papers in volume GE-1 No. 1 and only three papers in volume GE-2 No. 1 (November 1964). Although all the early papers dealt with solid-earth electro-seismic instrumentation, this fledgling Group had much broader goals in mind.

Alan W. Trorey[3], the first Transactions Editor, wrote the first article to be published in volume GE-1 (Dec. 1963) of this new journal. He entitled it "From Geo-Wireless to Geoscience Electronics" and envisioned the role that the Transactions would seek to play, as indicated in this excerpt:



Alan W. Trorey
First Transactions Editor

> "… Logically then, it would seem that any journal entitled TRANSACTIONS ON GEOSCIENCE ELECTRONICS should solicit and accept for publication any good paper in virtually any area of science, including even biology, zoology, and the behavioral sciences. If such a policy were followed, however, the TRANSACTIONS would not serve a useful purpose. To be of benefit to the scientific and engineering community, papers which already have well-defined outlets available to them in other existing journals should not normally appear in the TRANSACTIONS. Furthermore, papers need to be of mutual interest to both the electronic scientist and the geoscientist. As we have seen, there is a large area of interest common to the two groups. Both are interested in similar natural phenomena and both are involved with electronic instrumentation used in the study of these phenomena. This, then, defines our publication policy. Even though the boundary of this policy is vague at best, it will be the guide used by the editorial staff in deciding whether or not the subject matter of a paper is suitable for publication in the TRANSACTIONS. The papers in this first issue have been selected by attempting to follow this policy."

In addition to this lead-off article, there were four technical papers published in this first Transactions. Three of these had to do with seismic waves and instrumentation, and one was on oceanographic instrumentation.

Year (Oct.)	Chairman / President	Vice-Chm.	Secr.-Treasurer	Transactions Editor	Newsletter Editor
1962	R. W. Olson	H. W. Smith		None	E. B. Neitzel
1963	H. W. Smith	A. E. Tilley	E. B. Neitzel	A. W. Trorey	E. B. Neitzel
1964	A. E. Tilley	B. S. Melton	E. B. Neitzel	A. W. Trorey	E. B. Neitzel
1965	I. Katz	B. S. Melton	E. B. Neitzel	A. W. Trorey	E. B. Neitzel
1966	W. A. Drews	E. B. Neitzel	R. R. Ross	A. A. J. Hoffman	T. J. Hickley
1967	W. A. Drews	E. A. Wolff	R. R. Ross	A. A. J. Hoffman	T. J. Hickley
1968	E. A. Wolff	M. E. Ringenbach	R. R. Ross	A. A. J. Hoffman	M. T. Miyasaki
1969	E. A. Wolff	H. S. Field	J. C. Redmond	A. A. J. Hoffman	M. T. Miyasaki
1970	H. S. Field	J. C. Redmond	J. C. Redmond	A. A. J. Hoffman	M. T. Miyasaki
1971	J. C. Redmond	C. F. Getman	M. L. Sims	A. A. J. Hoffman	M. T. Miyasaki
1972	J. C. Redmond	C. F. Getman	M. L. Sims	S. Riter	M. T. Miyasaki
1973	C. F. Getman	M. L. Sims	J. W. Rouse	S. Riter	none
1974	M. L. Sims	J. W. Rouse Jr.	R. T. Lacoss	S. Riter	none
1975	J. W. Rouse Jr	R. T. Lacoss	C. D. McGillem	S. Riter	J. Eckerman
1976	C. D. McGillem	J. Eckerman	J. A. Schell Jr.	H. Kritikos	J. Eckerman
1977	J. Eckerman	A. F. Gangi	open	H. Kritikos	J. Eckerman
1978	A. A. J. Hoffman	H. Kritikos, H. J. Perlis	open	H. Kritikos	T. Walton
1979	A. A. J. Hoffman	H. N. Kritikos, H. J. Perlis	open	H. Kritikos	T. Walton

Table 1. G-GE Officers 1962 - 1979

[3] then at California Research Corporation, La Habra, California

G-GE Expands Scope In 1967 the first Transactions article dealing with oceanographic under-sea instrumentation was published. The November 1968 Transactions (volume GE-6) was its first Special Issue, on Oceanographic Instrumentation, guest edited by Gilbert Jaffe. The lead article was entitled "Oceanographic Instrumentation: A Crisis of National Neglect," by Harvey D. Kushner. This article, quoting from a 1967 speech by then Vice-President Hubert H. Humphrey, outlined some of the then-current problems of oceanographic instrumentation and exhorted the Federal Government to provide assistance in the advancement of state-of-the-art-technology and improvement in the quality of oceanographic instrumentation.

Edward A. Wolff
G-GE Chairman
1968, 1969

By 1968 the Group on Geoscience Electronics had thus established a significant technical presence in two fields - geophysics and oceanography. The addition of a third field - meteorology - was soon to follow. This expansion of activities was spearheaded by Edward A. Wolff[4], the new G-GE AdCom Chairman. In an editorial published in the May 1968 Transactions, Ed Wolff emphasized that the society should not only be concerned with individual geoscientific disciplines, but also their interactions. In this article he clearly foresaw that the Group (and later the Society) would become involved in interdisciplinary geoscientific studies and instrumentation, which certainly proved to be the case.

Under Ed Wolff's leadership, G-GE activities significantly increased in 1969. Annual dues were increased 25% to $5, and the group conducted its first annual International Geoscience Electronics Symposium. G-GE also arranged a session on oceanography at the IEEE International Convention in New York as well as technical sessions at the first Offshore Technology Conference held in Houston that April. The number of Transactions pages planned was increased to 300, and the group presented the first award in its newly adopted awards program. The G-GE AdCom also that year voted for full group participation in the National Telemetering Conference and allocated an initial contribution of $2000 for this purpose.

During the 1970's, G-GE successfully resisted an IEEE political problem. There was a faction in the IEEE hierarchy that believed that small was bad, at least in terms of membership. G-GE membership had declined to about 1200 by 1975, thus becoming the second or third smallest group in the IEEE. This faction of the IEEE was pushing for a merger of G-GE into the Aerospace and Electronic Systems Society (AES). They did succeed in merging the two Washington chapters, although the jointness was soon forgotten with the preponderance of AES members. However, G-GE itself survived as a separate group, and soon became a more multidisciplinary organization.[5]

G-GE International Symposia The First Annual International Geoscience Electronics Symposium, sponsored by G-GE was held from April 16-18, 1969, at the Twin Bridges Marriott Hotel, Washington, D.C. Arrangements for this symposium were handled by the host Washington Chapter of G-GE. The Steering Committee Chairman of this meeting was Charles F. Getman, then with the U.S. Naval Oceanographic Office in Washington. This first meeting turned out to be a great success, with 376 engineers and scientists in attendance. There were 63 papers presented in 13 technical sessions on topics such as earth resources surveys, oceanographic and meteorological remote sensing, earth seismology instrumentation, and environmental pollution. Although no digest of papers was published for this symposium, a Special Issue composed of selected papers from this meeting was published in the October 1969 (GE-7) Transactions on Geoscience Electronics. The banquet speaker at this first symposium was Professor Paul S. Bauer. The registration fee for IEEE members was $17.00.

The 2nd International Geoscience Electronics Symposium was held April 14-17, 1970 in Washington, D.C. at the Marriott Twin Bridges Motel, and was chaired by Michael L. Sims. There were 70 papers presented in 18 sessions, and a 100-page Digest of papers was published. This successful meeting included an awards banquet on April 16, with the speaker being U.S. Senator Warren G. Magnuson. Senator Magnuson called for the creation of a World Environment Institute to provide an international, interdisciplinary approach to global environmental problems. As a result of his suggestion, a G-GE team composed of Enrico Mercanti, Mace Miyasaki, and Ed Wolff began a survey of the world's environmental community and possible implementation arrangements for a World Environment and Resources Council (WERC). In 1971 the G-GE obtained support from the IEEE Technical Activities Board and TAB Vice-President Harold Chestnut to hold a first exploratory meeting from the world environmental community to form the WERC. This meeting was held in Washington, D.C. on August 26-27, 1971, at the time of the IEEE G-GE 1971 Annual Symposium.

The 3rd International Geoscience Electronics Symposium was also held in Washington, August 25-27, 1971. The General Chairman was Ralph Bernstein, with the IBM Corporation. There were 47 papers published in a 78-page Digest. Attendance at this third meeting was only about 150, much lower than the previous two years, and substantially fewer than were needed for the meeting to be a financial success.

Geoscience and Remote Sensing Society (GRSS)

In 1979 the AdCom of the Group on Geoscience Electronics (G-GE) voted to change its name to the Geoscience and Remote Sensing Society (GRSS), and to change the name of its journal to the Transactions on Geoscience and Remote

[4] at that time, Ed Wolff was the Director od Research, Pulse Communications Inc., Alexandria, Virginia. He later worked for Geotronics Inc. (Falls Church, Virginia) and still later with NASA Goddard Space Flight Center, Greenbelt, Maryland.
5 private communication, Ed Wolff, Nov. 19, 1995.

Sensing. This initiative recognized the strong linkage among the various geoscientific disciplines and the powerful techniques of remote sensing and the importance of these topics to the membership. The impetus for this change came from Fawwaz T. Ulaby, a new member of the AdCom and then Professor of Electrical Engineering at the University of Kansas.[6] This change was supported by other key members of the AdCom, and was approved by the IEEE Executive Committee in December 1979. In a preface to the January 1980 issue of the Transactions, GRSS President Ulaby noted that the term "remote sensing" in the sense used by the new GRSS was broadly defined "to include observations from spaceborne and airborne platforms, as well as seismic recording of the earth's subsurface and sonar mapping of the ocean floor."

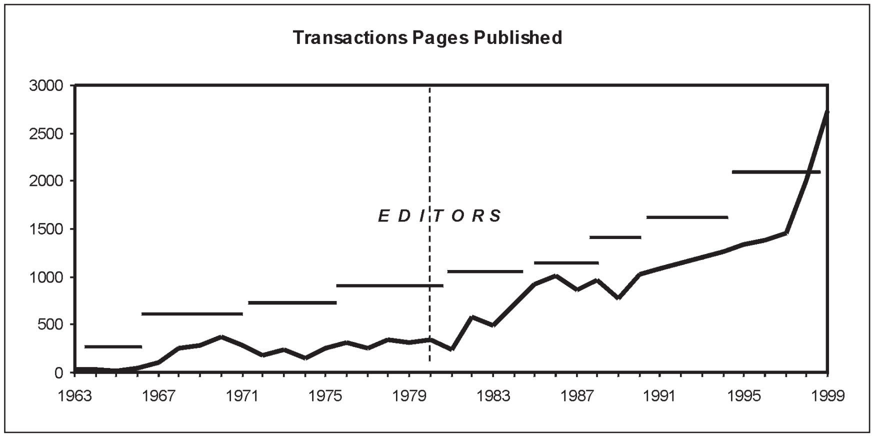


Figure 2. Transactions Pages Published

Transactions GRSS The first issue of the newly named *IEEE Transactions on Geoscience & Remote Sensing* (volume GE-18, No. 1) was published in January 1980 under the editorship of Professor Harry Kritikos, University of Pennsylvania. As before, there were four issues published per year. By 1984 paper submissions had increased to the point that the AdCom decided to publish six issues per year. The increased number of papers was due in part to a decision to publish an annual IGARSS special issue, composed of selected papers presented at the annual symposium.

With an increasing number of papers being submitted over a wide variety of technical areas, the Editors after Harry Kritikos began to add Associate Editors, as well as Guest Editors for special topics. For example, in 1999 there were two specialized topic issues, one on Data Fusion and the other on the ADEOS satellite system. These special issues have proven to have immense value to researchers, providing convenient access to a large group of papers on relevant aspects of a single subject or application

As seen in Figure 1, the Executive Editors looked somewhat younger when they took the job than when they finished. The number of Transactions pages published annually has grown significantly, from 36 pages in 1963, to 253 pages in 1981, to over 2700 pages currently, as shown in Figure 2.

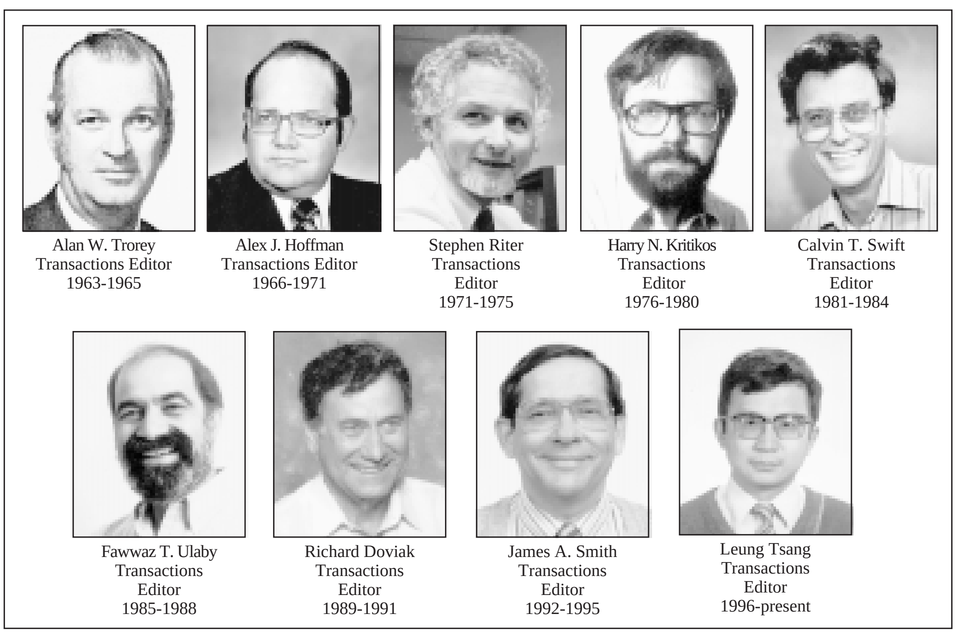


Figure 1. Executive Editors of Trans. G-GE and Trans. GRSS

GRSS AdComs, Officers and Leaders Engineers and scientists in the field of geoscience electronics and remote sensing routinely turn to the IEEE Transactions on Geoscience & Remote Sensing as an archive of important refereed papers and information. They also rely on the annual IGARSS for late-breaking information and the opportunity for informal discussions with their colleagues. These "users" owe a debt of gratitude not only to the authors, but also to the many volunteers who have guided the Society to its present-day status. In the formative years of the Geoscience and Electronics Society, it was a challenging task for the Editor to publish a Transactions issue with a respectable num-

[6] Fawwaz Ulaby is now Vice President for Research at the University of Michigan, and the R. Jamison & Betty Williams Professor of Electrical Engineering and Computer Science.

Year	President	Vice-President	Secretary/ Treasurer	Transactions Editor	Newsletter Editor	**Symposium** General Chairman
1980	F. T. Ulaby	H. J. Perlis, H. N. Kritikos	K. R. Carver	H. N. Kritikos	W. T. Walton	
1981	F. T. Ulaby	K. R. Carver, R. J. Lytle	R. E. McIntosh	C. T. Swift	J. Crawford	F. T. Ulaby
1982	K. R. Carver	R. J. Lytle, L. R. Breslau	R. E. McIntosh	C. T. Swift	C. Balanis	J. Bodechtel
1983	K. R. Carver	R. J. Lytle, L. R. Breslau	R. E. McIntosh	C. T. Swift	C. Balanis	K. R. Carver
1984	R. E. McIntosh	A. J. Sieber, C. A. Balanis	J. A. Reagan	C. T. Swift	A. Blanchard	P. Gudmandsen
1985	C. T. Swift	A. Sieber	J. A. Reagan	F. T. Ulaby	A. Blanchard	R. E. McIntosh
1986	D. Landgrebe	R. K. Raney	J. A. Reagan	F. T. Ulaby	R. Newton	H. Haefner
1987	D. Landgrebe	R. K. Raney	J. A. Reagan	F. T. Ulaby	J B Cimino	F. T. Ulaby
1988	R. K. Raney	J. A. Reagan	M. C. Dobson	F. T. Ulaby	J B Cimino	D. D. Hardy
1989	R. K. Raney	J. A. Reagan	M. C. Dobson	R. Doviak	J B Cimino	J. S. MacDonald
1990	J. A. Reagan	D. Goodenough	G. H. Ludwig M. C. Dobson	R. Doviak	J B Way	V. V. Salomonson
1991	J. A. Reagan	D. Goodenough	G. H. Ludwig M. C. Dobson	J. A. Smith	J B Way	M. Hallakainen
1992	D. Goodenough	J B Way	R. M. Hardesty A. J. Blanchard	J. A. Smith	J B Way	A. J. Blanchard
1993	D. Goodenough	A. J. Blanchard	R. M. Hardesty J. Gatlin	J. A. Smith	R. M. Narayanan	M. Takagi
1994	A. J. Blanchard	M. T. Hallikainen	R. M. Hardesty J. Gatlin	J. A. Smith	R. M. Narayanan	J B Way & D. McCleese
1995	A. Blanchard	M. T. Hallikainen	R. M. Hardesty, J. Gatlin	J. A. Smith	S. Gogineni	P. Pampaloni
1996	M. T. Hallikainen	N. Khazenie	T. Jackson	L. Tsang	S. Gogenini	R. Narayanan
1997	M. T. Hallikainen	N. Khazenie	T. Jackson	L. Tsang	C. Ruf	H. Lim
1998	N. Khazenie	W. Wiesbeck	T. Jackson	L. Tsang	C. Ruf	L. Tsang
1999	N. Khazenie	W. Wiesbeck	T. Jackson	L. Tsang	C. Ruf	W. Alpers
2000	W. Wiesbeck	C. Luther	T. Jackson	L. Tsang	S. Reising	A. Blanchard & D. Goodenough

Table 2. GRSS Officers 1980 – 2000

ber of papers. The Society was not well-known, and it took many years to reach critical mass. Then, as now, the publication of the Transactions was expensive. These publication costs and recovery of page charges dominated the budgetary concerns of the AdCom. Since that time, hundreds of dedicated professionals have served on the AdCom, as Editors, as Chairs of standing committees, in IGARSS leadership, or otherwise have contributed significantly to GRSS. These efforts have resulted in a well-managed Society, a prestigious Transactions and the recognition of IGARSS as the leading remote sensing international symposium.

The elected GRSS officers, Editors, and IGARSS General Chairs are listed in Table 2. Each one of these individuals contributed enormously to the Society's growth and success. Space limitations preclude the recognition of the other officers and members who have worked so hard to make GRSS a success. A photo gallery of elected Chairmen and Presidents of the G-GE and GRSS AdCom is shown in Figure 3.

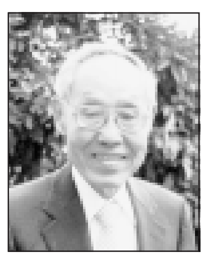
GRSS Newsletter The Geoscience Electronics Group published a Newsletter from its inception. The Newsletter has been continued by the Geoscience and Remote Sensing Society and enlarged within recent years to typically twenty pages in length with feature articles, book reviews, organizational profiles, chapter activities and announcements of upcoming IGARSS meetings, workshops, and other conferences. The Newsletter has always been an effective means of disseminating information about GRSS activities, broader IEEE issues, calls for papers, etc. When GRSS was formed in 1980, G-GE Newsletter Editor Travis "Trav" Walton continued to serve under the new GRSS masthead. In the early years it was sometimes difficult for the Newsletter Editor to gather GRSS-related articles of general membership interest, so issues were often thin. In recent years the Newsletter has grown, with issues regularly including a wide range of articles on many technical and scientific topics of interest to members, accomplishments of individual members, and the various laboratories from academe, industry and government agencies that conduct research in geoscience electron-

Figure 3. Presidents, Chairman of GRSS, G-GE

ics and remote sensing. The growth of the Newsletter has been accompanied by some recent management changes. The Editor now heads an Editorial Board that includes Associate Editors for University Profiles, Review Articles, European Affairs, and Organizational Profiles. The Associate Editors solicit and feature activities in their areas that are of significance and interest to the membership. Recent issues also provide improved visual appeal, with a cover page in color, the GRSS colorful logo, and advanced printing techniques. The Newsletter Editors are shown in Figure 4.

Society Membership In 1963 the total membership in G-GE was approximately 800, including 34 students. In 1992 membership peaked at 2800 and is currently about 2300, as shown in Figure 5.

G-GE and GRSS Awards The first series of G-GE awards was adopted by the AdCom in 1968. A Best Transactions Paper Award was created to recognize the author(s) of the best Transactions paper in the preceding year, and an Outstanding Symposium Presentation Award was also created. The selection of the Best Transactions Paper Award was guided by the Editor, who made a recommendation to the G-GE Awards Committee. The Best Transactions Paper Award for 1968 was presented to Bob LaCoss, whose paper appears in the May issue of that year. The Awards Committee also coordinated nominations of G-GE members for IEEE Fellow, and instituted special certificates of appreciation for past G-GE officers, past Transactions and Newsletter Editors, and past Symposium chairmen. No systematic record of these awards has been found for the decade beginning in 1970.



Kiyo Tomiyasu, First GRSS Awards Chairman

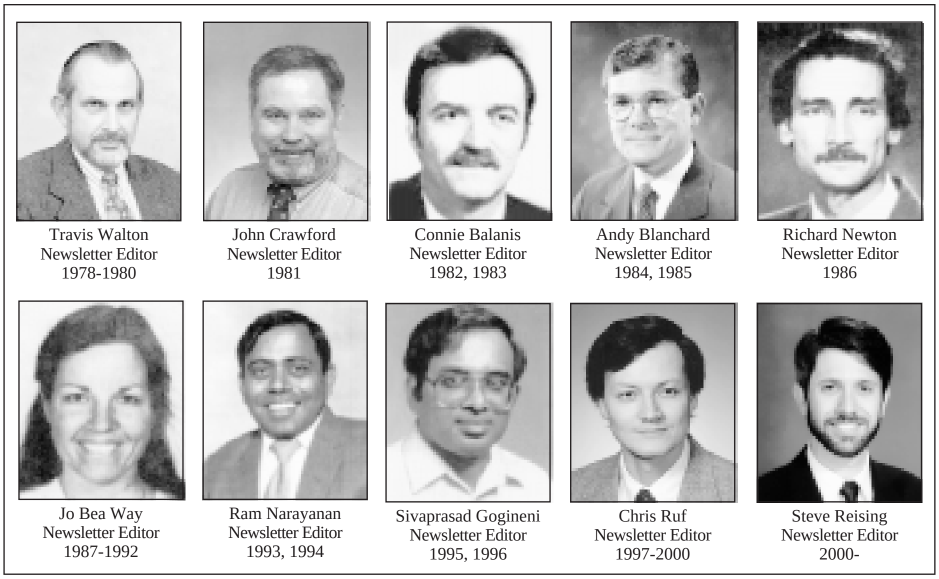


Figure 4. Newsletter Editors 1978 – 2000

In 1981 the GRSS AdCom moved to revitalize its awards activities. This initiative was led by Kiyo Tomiyasu, then with the General Electric Valley Forge Space Center in Pennsylvania. Kiyo Tomiyasu served as Chairman of the GRSS Awards Committee for many years. In 1981 he proposed to the GRSS AdCom a series of awards that would recognize and encourage excellence in service to the Society, distinguished technical contributions, outstanding Transactions papers and exceptional IGARSS conference papers. In addition to these GRSS awards, the Society also had a Fellows Committee to consider nominations of outstanding Society members for Fellow of the IEEE.

The Distinguished Achievement Award was established by the GRSS to recognize an individual "who has made significant technical contributions, usually over a sustained period. The contribution shall fall within the technical scope of the GRSS." IEEE membership is preferred for the recipient of this award, but is not required. This award includes a plaque and a certificate. The first recipient of the GRSS Distinguished Achievement Award was Professor Richard K. Moore, University of Kansas, who was recognized for "his significant technical contributions over a sustained period in the field of microwave remote sensing."

Richard K. Moore, First recipient of GRSS Distinguished Achievement Award

The Outstanding Service Award was established by the GRSS to recognize an individual "who has given outstanding service for the benefit and advancement of the IEEE Geoscience and Remote Sensing Society. In selecting the individual, the suggested factors are leadership, innovation, activity, service, duration, breadth of participation, and cooperation. The individual must be a member of the GRSS. The recipient shall receive a certificate." The first recipient of the GRSS Outstanding Service Award (1981) was Professor Harry Kritikos, University of Pennsylvania, who was recognized for "his outstanding services for the benefit and advancement of the Geoscience and Remote Sensing Society."

Harry Kritikos, First recipient of GRSS Outstanding Service Award

The Best Transactions Paper Award was established to recognize the author(s) who has published in the IEEE GRS Transactions during the calendar year "an outstanding paper in terms of content and impact on the Geoscience and Remote Sensing Society. If a suitable paper cannot be found among those published during the calendar year, papers published in prior years and subsequently recognized as meritorious may be considered. In selecting the paper, other suggested factors considered are timeliness and clarity. IEEE membership is preferable but not required." Of the papers published in calendar year 1981, the paper selected for the 1982 Best Transactions Paper Award was "Inclusion of a Simple Vegetation Layer in Terrain Temperature Models for Thermal IR Signature Prediction," by Lee K. Balick, R. K. Scoggins, and L. E. Link, Jr. (GE-19, pp. 143-152, July 1981).

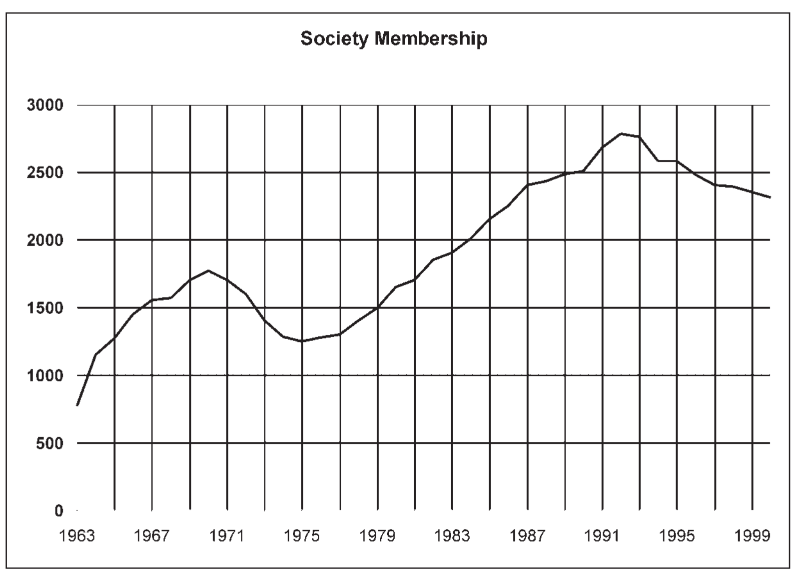


Figure 5. GRSS and G-GE Membership 1963 - 2000.

IEEE Centennial Medals. In 1984 the IEEE celebrated its 100th anniversary and established the Centennial Medal Program to honor individuals to be recognized for their loyal and dedicated service to the Institute and to the profession. There were 8 GRSS recipients of the IEEE Centennial Medal and Certificates who were recognized at the IGARSS'84 meeting in Strasbourg: Keith R. Carver (Univ. of Massachusetts), Jerome Eckerman (NASA Goddard Space Flight Center), Haralambos T. Kritikos (Univ. of Pennsylvania), Robert E. McIntosh (Univ. of Massachusetts), Richard K. Moore (Univ. of Kansas), Alois J. Sieber (DFVLR – Oberpfaffenhofen), Calvin T. Swift (Univ. of Massachusetts), and Fawwaz T. Ulaby (Univ. of Kansas).

Honorary Life Members. Three GRSS members have been elected to the position of Honorary Life Member of the AdCom: Fawwaz T. Ulaby, Keith R. Carver, and Kiyo Tomiyasu.

IEEE Fellows in GRSS. As of January 1, 2000, there were 116 GRSS members who have been elected to the grade of Fellow of the IEEE.

G-GE and GRSS Chapters Locally organized GRSS chapters have provided a means for further enhancing the value of the Society to local membership, through sponsorship of lectures or seminars on topics of interest, social activities, etc. In recent years, the Society has created a Distinguished Speaker Program designed specifically to enhance chapter activities by providing nationally known speakers on geoscience and remote sensing topics of interest.

The first Chapter of the G-GE was formed on December 11, 1962 in Houston, Texas, and was chaired by L. B. McManis. By 1968 activity had expanded to five regular chapters located in Houston, Los Angeles, Washington, Tulsa and Providence. That year, the Houston Chapter was chaired by R. J. Schwartz, the Los Angeles Chapter by Martin N. Kaplin, the Washington Chapter by Edward W. Bisone, the Tulsa Chapter by John L. Shanks and the Providence, Rhode Island Chapter by Arthur S. Westneat. Since G-GE was one of the smallest IEEE technical societies, attendance at chapter meetings ranged from poor (4 - 5) to excellent (over 30). Chapter chairmen arranged for dinner speakers, local plant tours, and other activities of interest to G-GE members. The Washington Chapter was particularly active during the late 1960's, and coordinated the three G-GE symposia held in Washington in 1969, 1970 and 1971. Total membership in GE or GRSS was generally less than 1500, so that only a few metropolitan areas had sufficient members to form the chapter with critical mass.

By 1995 there were eleven GRSS Chapters, located in Boston, Massachusetts; Springfield, Massachusetts; Washington/Northern Virginia; Atlanta; Southeastern Michigan; Denver; Houston; Los Angeles; Oakland/East Bay; Toronto; and Tokyo. Most of these are joint chapters with other IEEE chapters of Societies: Antennas & Propagation, Aerospace and Electronics, etc. Chapter activities have been enhanced by the availability of GRSS-sponsored Distinguished Speakers, who are recognized experts in various areas of geoscience and remote sensing.

International Geoscience and Remote Sensing Symposium (IGARSS)

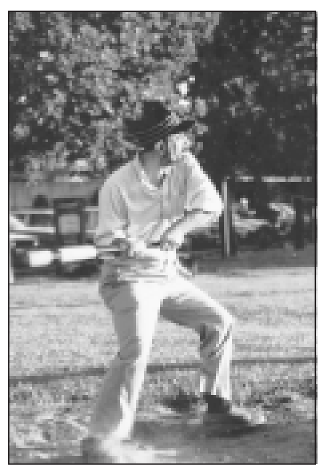
In 1980 then-President Fawwaz Ulaby led a major initiative for the Society to renew its sponsorship of an annual international symposium on geoscience and remote sensing. The series of three international annual G-GE symposia that had begun in 1969 were discontinued from 1972 - 1980, partly due to AdCom concerns about the financial losses incurred in the 1971 meeting. By 1980, however, there was a rapidly increasing interest in new satellite-borne remote sensor systems such as the Earth Resources Technology Satellite (ERTS) as well as parallel advances in solid-earth sensing, atmospheric and oceanographic remote sensing techniques and sensor systems. In the U.S. major new remote sensing initiatives were being led by NASA, NOAA, USGS, etc. Outside the U.S., new missions were being planned by agencies in Canada (CCRS), Europe (ESA), Japan (NASDA) and in a number of other countries. There was no well-organized annual remote sensing international symposium where there was balanced emphasis on all branches of geoscience as well as instrumentation and information processing. President Ulaby proposed to the GRSS AdCom that it should sponsor a new symposium series, to be called the International Geoscience and Remote Sensing Symposium (IGARSS). He suggested that IGARSS'81 be held in Washington, D.C. in the late spring of 1981, that it should have a strong international participation, and that it sponsor sessions in all of the technical areas of interest to the Society. He saw this as a way to revitalize the Society, to increase membership, and to make the GRSS Society known as a leader in the field of remote sensing. This proposal was supported by the AdCom, and plans were developed to hold IGARSS'81 at the Marriott Twin Bridges Hotel, site of the last Group symposium in 1971.

IGARSS'82 reception, from left: Johannes Bodechtel, Keith Carver, Connie Taranik, Jim Taranik, Bavarian Minister for Science and Education, Alois Sieber.

Meeting	Location	Date	Registrations	Countries	Gen. Chm.	Tech. Prog. Chm.
IGARSS'81	Washington, DC, USA	June 8 – 10, 1981	431	16	F. Ulaby	K. Carver
IGARSS'82	Munich,W. Germany	June 1 – 4, 1982	359	27	J. Bodechtel	P. Hartl
IGARSS'83	San Francisco, Calif.,USA	Aug. 31 – Sept 2, 1983	368	18	K. Carver	D. G. Rea & D. Weissman
IGARSS'84	Strasbourg, France	Aug 27 – 30, 1984	261	17	P. Gudmansen	W. Keydel
IGARSS'85	Amherst, Mass, USA	Oct. 7 – 9, 1985	444	21	R. McIntosh	C. Swift
IGARSS'86	Zurich, Switzerland	Sept. 8 – 11, 1986	473	29	C. Haefner	K. Itten
IGARSS'87	Ann Arbor, Mich., USA	May 18 – 21, 1987	448	23	F. Ulaby	K. Carver
IGARSS'88	Edinburgh, Scotland	Sept. 12 – 16, 1988	346	32	D. D. Hardy	P. L. Williams
IGARSS'89	Vancouver, B.C., Canada	July 10 – 14, 1989	> 1000	41	J. S. MacDonald	J. F. R. Gower
IGARSS'90	College Park, Md., USA	May 20 – 24, 1990	845	30	V. Salomonson	J. A. Smith
IGARSS'91	Helsinki, Finland	June 3 – 6, 1991	695	29	M. Hallikainen	M. Tiuri
IGARSS'92	Houston, Texas, USA	May 26 – 29, 1992	661	26	A. Blanchard	A. Fung, A. Sieber
IGARSS'93	Tokyo, Japan	Aug. 18 – 21, 1993	611	42	M. Takagi	S. Fujimura
IGARSS'94	Pasadena, Calif., USA	Aug. 8 – 12, 1994	854	33	J. B. Way & D. J. McCleese	E. Njoku
IGARSS'95	Florence, Italy	July 10 – 14, 1995	834	35	P. Pampaloni	P. Bruscaglioni
IGARSS'96	Lincoln, Nebraska, USA	May 2 – 31, 1996	769	31	R. Narayanan	R. Mcintosh, C. Swift
IGARSS'97	Singapore	August 4 – 8, 1997	513	34	H. Lim	T. S. Yeo et al.
IGARSS'98	Seattle, Washington, USA	July 6 – 10, 1998	1035	40	L. Tsang	Y. Kuga, D. Winebrenner
IGARSS'99	Hamburg, Germany	June 28 – July 2, 1999	882	45	W. Alpers	R. Banler, R. Winter
IGARSS'00	Honolulu, Hawaii	July 24 – 28, 2000			A. Blanchard, D. Goodenough	A. Gasiewski, K. St. Germain

Table 3. IGARSS meetings 1981 – 2000

UMass grad students at IGARSS'87 in Ann Arbor, from left: C. Ruf, I Popstefania, R. Narayanan, D. McLaughlin, A. Tanner.

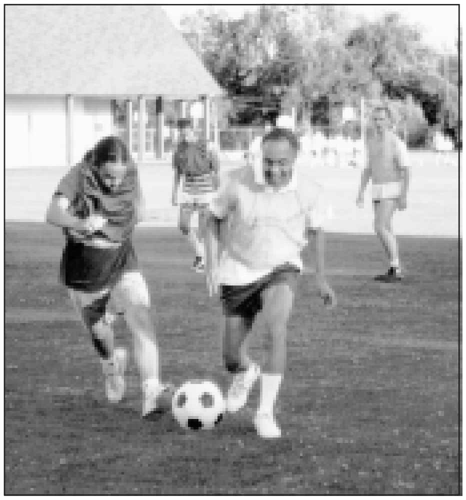


Fawwaz Ulaby at bat: IGARSS'89 baseball game in Vancouver.

IGARSS'81 was held June 8 - 10, 1981 at the Twin Bridges Marriott Hotel in Washington, D.C. The General Chairman was Fawwaz Ulaby, and the Technical Program Chairman was Keith Carver. There were 416 in attendance, and a comprehensive 2-volume Proceedings was published, with 1457 pages. The banquet speaker was Harrison Schmidt, a Senator from New Mexico and a former Apollo astronaut. This was the largest and most successful of the conferences that had been sponsored by the Society or its predecessor Group, and estab- lished the Society as a leading disseminator of information on the rapidly growing field of remote sensing and applications to geoscientific issues. Moreover, there were sixteen countries represented at IGARSS'81.

International Participation

The Institute of Electrical and Electronics Engineers (IEEE) is a transnational organization with global membership. While the roots of the IEEE Geoscience and Remote Sensing Society can be traced to a group of engineers and scientists primarily in the Southwestern United States, GRSS today attracts vigorous participation by engineers and scientists from around the world engaged in endeavors that are intrinsically global.



Eni Njoku shows the edge of experience at IGARSS'94 soccer game in Pasadena

Paolo Pampaloni & Simone Paloscia, IGARSS'95 in Florence

IGARSS 1981 – 2000 When plans were made for IGARSS'81 in Washington, it was envisioned by President Ulaby that many of the subsequent meetings would be held outside of the North American continent. Since 1981 the Society has alternated the sites of its annual IGARSS between cities in North America and cities outside North America.

Several key individuals played an important role in arranging for the second IGARSS to be held in Europe. These were Alois Sieber, Wolfgang Keydel, and Franz Schlude (all associated at that time with the German Aerospace Establishment DFVLR), along with Phil Hartl (University of Berlin) and Johannes Bodechtel (University of Munich) and others. The German organizing team worked closely with Fawwaz Ulaby, Keith Carver and other members of the AdCom to arrange for IGARSS'82 to be held in Munich. Even before IGARSS'81 was held in Washington, skeletal plans were in place to hold IGARSS'82 at the University of Munich. Professor Bodechtel of the University of Munich agreed to be General Chairman, and other key committee assignments were made. To celebrate, a reception for the IGARSS'81 participants was held during the symposium, at the National Air and Space Museum, just across Independence Avenue from NASA Headquarters. This enjoyable affair was hosted by the West German Embassy, whose Charge d'Affairs for Science and Technology announced that IGARSS'82 would be held in Munich. There were many initial questions among AdCom members about how the technical program and financial details would be worked out for the first IGARSS outside the U.S., but these details were all handled smoothly and efficiently by the German organizing team.

IGARSS'82 was a tremendous success and established this GRSS-sponsored symposium as the leading international conference on the topic of geoscience and remote sensing techniques. This achievement led to a 1982 AdCom decision to hold meetings both in the U.S. and every other year outside the U.S. IGARSS meetings in the U.S. have been held in Washington, San Francisco, Amherst, Ann Arbor, College Park, Houston, Pasadena, Lincoln, Seattle and Honolulu in July 2000. In addition to IGARSS'82 in Munich, IGARSS meetings have also been held in Strasbourg, Zurich, Edinburgh, Vancouver, Helsinki, Tokyo, Florence, Singapore, and Hamburg, as shown in Table 3. Starting with the IGARSS'86 meeting in Zurich, it has become the accepted practice to name meeting rooms after the cities in which IGARSS conferences have been held.

The printed version of the Proceedings of IGARSS has grown to be a heavy multi-volume publication, and the printing cost is a major element of each year's IGARSS budget. Starting with the IGARSS'95 meeting, the IGARSS Proceedings has also been issued on CD-ROM.

Recent GRSS Activities

In recent years the GRSS AdCom has made a number of changes to improve the functioning of the Society. For example, in 1995 an Executive Committee was instituted, recognizing that the position of President entails major responsibilities and that an expanded governance structure was required. The Executive Committee includes the President, an Executive Vice President, and four functional Vice Presidents assigned to Operations, Technical Committees, Meetings and Symposia, and Professional Activities. This new structure has significantly expedited the operational aspects of the AdCom.

In 1994 the AdCom decided to form Technical Committees addressing certain activities within GRSS. The currently active Technical Committees are Data Fusion, Data Standardization and Distribution, and Instrumentation and Future Technology. The effort to form these Technical Committees was led by Charles Luther for the first several years and resulted in a more focused organization in key technical areas of interest to GRSS. As a result of this effort, more detailed technical issues have been identified, culminating in various workshops sponsored by GRSS. These are seen as seeding Society professional growth by identifying, defining and pursuing areas for improved comprehension and operational significance. Recent examples are the First International Workshop on Pattern Recognition in Remote Sensing (PRRS) to be held in Andorra in September 2000, and the microCal Workshop to be held at the University of Maryland Conference Facility in October 2000.

IGARSS also continues to be a major focus of GRSS, with meetings planned several years in advance. Upcoming meetings are IGARSS 2000 (Honolulu, Hawaii), IGARSS 2001 (Sydney, Australia), IGARSS 2002 (Toronto, Canada), IGARSS 2003 (Toulouse, France), IGARSS 2004 (Anchorage, Alaska), IGARSS 2005 (Seoul, Korea), and IGARSS 2006 (Boulder, Colorado).

Concluding Remarks

From its embryonic beginnings nearly four decades ago in the field of geoscientific instrumentation for petroleum exploration, the IEEE GRSS has matured into the leading international organization for the exchange and dissemination of information, embracing the entire spectrum of geoscientific inquiry, the development of novel instrumentation techniques, global measurement systems, image information, and applications to a better understanding of our Earth. The success of GRSS is due to the sustained efforts of many dedicated professionals who have served as elected officers, Transactions Editors, Newsletter Editors, authors and reviewers of journal papers and Newsletter articles, organizers of IGARSS meetings and topical workshops, and as Chapter officers. As we continue to expand our geoscientific understanding and to develop even more advanced remote sensing techniques, GRSS has an exciting bright future for growth in the new millenium.

Acknowledgements

I wish to thank Kiyo Tomiyasu not only for his encouragement to compile this history, but also his direct contributions to this article by providing information on recent GRSS activities. Kiyo is a remarkable individual whose sustained contributions to GRSS over the past two decades are truly exceptional. I also appreciate the help provided by Ed Wolff, especially about the early development of G-GE. Steve Reising, the new Newsletter Editor, was instrumental in tracking down missing photos and other key details from recent years. Finally, I thank my good friend Fawwaz Ulaby for his visionary leadership in the formative years of GRSS, and so many other friends and colleagues in GRSS who have contributed to the success of the IEEE Geoscience and Remote Sensing Society.

Development of Microwave Emission Models of Snowpacks

Christian Mätzler, Andreas Wiesmann, Jouni Pulliainen and Martti Hallikainen

1. Passive Microwave Remote Sensing of Snow

Discovering microwave signatures of snowpacks and firn

Passive microwave signatures of seasonal snowpacks are well known by their strong contrast between wet and dry snow, by the decreasing emissivity for dry snow with increasing frequency (10 to 100 GHz range) and by their potential to give snow-volume information in the case of dry snow. Signatures have been observed for over 30 years mainly by ground-based studies (e.g. Kennedy and Sakomoto, 1966; Hofer and Schanda, 1978; Stiles and Ulaby, 1980; Ulaby and Stiles 1980; Mätzler 1987, 1994; Wiesmann et al., 1998), but also from aircraft and indirectly also from satellite observations (e.g. McFarland et al., 1987; Josberger et al., 1993). An early review of the potential and limitations for remote sensing was published by Bernier (1987). A recent study, covering frequencies up to 220 GHz (Tait et al., 1999) showed that volume-scattering signatures of snowpacks continue throughout the mm wavelength range.

Different microwave signatures were observed for the perennial snow and firn on polar ice sheets (Gurvich et al., 1973; Gloersen et al., 1974; Zhang et al., 1989; Rott, 1989; Rott et al., 1993). The lowest emissivities are often observed at low microwave frequencies around 10 GHz. This property is a consequence of the large depth of scattering layers coupled with the increase of grain size with increasing depth to which low-frequency radiation can better penetrate, typically from 10 m at 10 GHz to at most 1 m at 35 GHz (Rott 1989, Mätzler 1987).

Search for direct inversion algorithms and why physical modeling is better

With variable success, different researchers developed algorithms, based on spectral features, to retrieve the water equivalent of snowpacks from satellite radiometer data (e.g. Hallikainen and Jolma, 1986; Chang et al., 1987; Wang et al., 1992; Goodison and Walker, 1995; Tait and Armstrong, 1996; De Sève et al., 1997). Although high correlations were found using algorithms for snow depth under special conditions, the usefulness of these empirical models was limited to specific geographic regions and special snowpack histories (Rango et al., 1979; Foster et al., 1980; Künzi et al., 1982). Rott and Nagler (1995) showed that different snow types (wet snow, snow with crusts, dry snow) can well be delineated, but that a universal algorithm for snow water equivalent does not exist. Mätzler (1994) found from surface-based experiments that snow structure and layering of dry snow can dominate the signal. Tait and Armstrong (1996), being aware of special snowpack signatures, tried to optimize snow-depth algorithms by excluding certain data (types of snowpacks, special regions and weather conditions). These experiences tell us that a more physical approach, including all snow parameters, would be more adequate than empirical algorithms for single parameters. Valuable geophysical information can be gained through a physical analysis that yields diverse snow properties, not only the water equivalent. Parameters to be derived from snow structure are the optical albedo and the diffusivity for mass and heat transfer within the snowpack. Furthermore, in a physical treatment it is possible to include the relief (Mätzler and Standley, 1999) and the background radiation. Recent experiments showed that even the background radiation can be measured through dry, alpine snowpacks, and that the data are useful for permafrost mapping by microwave radiometry at frequencies near 10 GHz (Gubler and Hauck, 1998).

2. Modeling Efforts for Seasonal Snow and Ice Sheets

In order to understand the influence of snowpack properties on the microwave signal and to explain snow signatures, theoretical investigations have been performed using both electromagnetic wave theory (Tsang, 1987; Stogryn, 1986; Surdyk and Fily, 1995) and radiative transfer (e.g. Chang et al. 1976; Tsang and Kong, 1977). So far it has been difficult to validate the results of modeling efforts mainly because snow structure is difficult to quantify. If it is described by grain size one needs realistic size distributions. Such distributions are often hypothetical because of the required assumptions about grain shape (e.g. Jin, 1995). An alternative is to use the Born approximation or the Strong Fluctuation Theory (SFT) where the structure can be quantified by the correlation length, a quantity measurable from snow sections (e.g. Reber et al. 1987). The SFT model of Stogryn (1986) was tested by Weise (1996a) in the implementation of Surdyk (1992), using Weise's own experimental data. The validation showed that the model is inaccurate, probably because multiple scattering is ignored in SFT. Indeed, West et al. (1993) showed, on the basis of the dense-medium radiative transfer theory applied to backscattering from snow, that multiple scattering by snow grains is important.

The development of snowpack emission models is further complicated by the fact that snow profiles show strong vertical inhomogeneity. Since the penetration depth of microwaves and the scattering coefficient depend on frequency and snow properties, a general model should account for realistic snow profiles of all sensitive parameters. A successful model might then be used for the development of remote sensing tools for observing processes on and within the snowpack. is Temperature-gradient metamorphism, an important internal process, modifies heat and vapor transfer, is responsible for the release of avalanches, and often takes place near the bottom of the snowpack. This process is based on large water-vapor gradients; it leads to the formation of cohesionless depth hoar (Armstrong, 1977, 1985). Microwave emission of depth-hoar layers is very distinctive due to the enhanced volume-scattering by the large crystals (Weise, 1996a,b). On the other hand, snowpack stratification has important implications for physical processes, such as avalanche formation by weak layers (Föhn et al. 1998; Fierz, 1998), reduced vertical diffusion of water vapor and heat transfer, and percolation of liquid water in the case of wet snow (Arons and Colbeck, 1995, and references therein). Snow layers also mark meteorological events in the history of snowpacks, and therefore they contain information about past weather conditions. Specific microwave signatures related to stratification are expressed, for instance, by polarization features of microwave emission, and sometimes by special spectral properties. Since the earliest radiometric observations, interest has been paid to layering of polar ice sheets (Gurvich et al. 1973; Rott et al. 1993; Surdyk and Fily, 1995; Steffen et al. 1999), and layer effects were also found in snow-covered sea ice (e.g. Mätzler et al. 1984). Microwave emission of layered media, such as firn, was computed in the past by several authors (e.g. Gurvich et al. 1973; Djermakoye and Kong 1979; West et al. 1996). Other models were related to volume scattering by the granular firn structure (e.g. Zwally, 1977).

Driven by the need for realistic microwave emission models for radiometry that combine both land and atmosphere and include vegetation and snowpacks, ESA launched a study to combine theoretical and experimental investigations in 1995. Two different snowpack emission models evolved from this initiative (Pulliainen et al. 1998): A single-layer model, developed at the Helsinki University of Technology, called the "HUT Model", and the Microwave Emission Model of Layered Snowpacks (MEMLS), developed at the University of Bern. Whereas the first model is a semi-empirical, single-scattering model suitable for rapid emission computation, the second one is a more sophisticated model suitable for simulations of all kinds of physical effects. Both models are described below.

The HUT Model

The HUT Model describes the snowpack as a single homogeneous layer and uses an empirical formulation for the snow extinction coefficient and an empirical forward scattering factor. It assumes that the scattering is mostly concentrated in the forward direction. The snow extinction coefficient is modeled as a func-

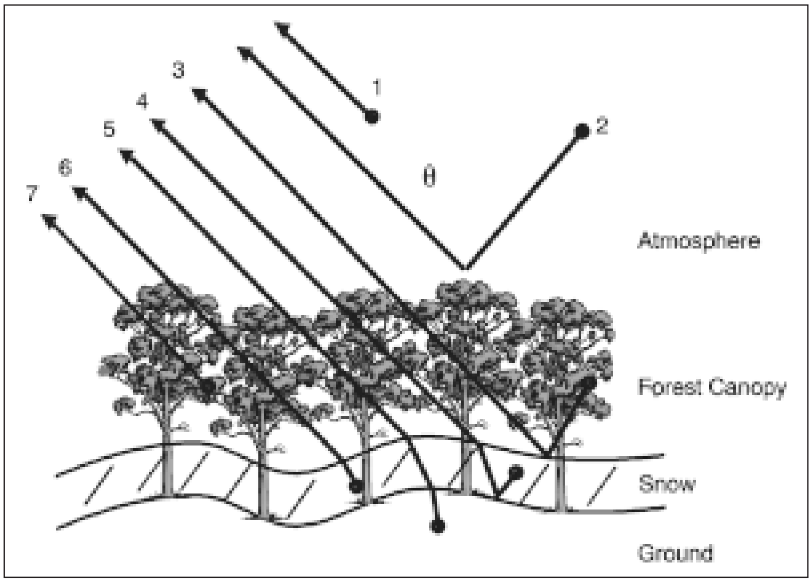


Figure 1: Schematic presentation of the main emission contributions included in the HUT snow emission model. The contributions are:
1: upward emitted atmospheric radiation
2: downward emitted reflected atmospheric contribution
3: downward emitted reflected forest canopy emission contribution
4: downward emitted reflected snowpack emission contribution
5: upward emitted soil emission contribution
6: upward emitted snowpack emission contribution
7: upward emitted forest canopy emission contribution.

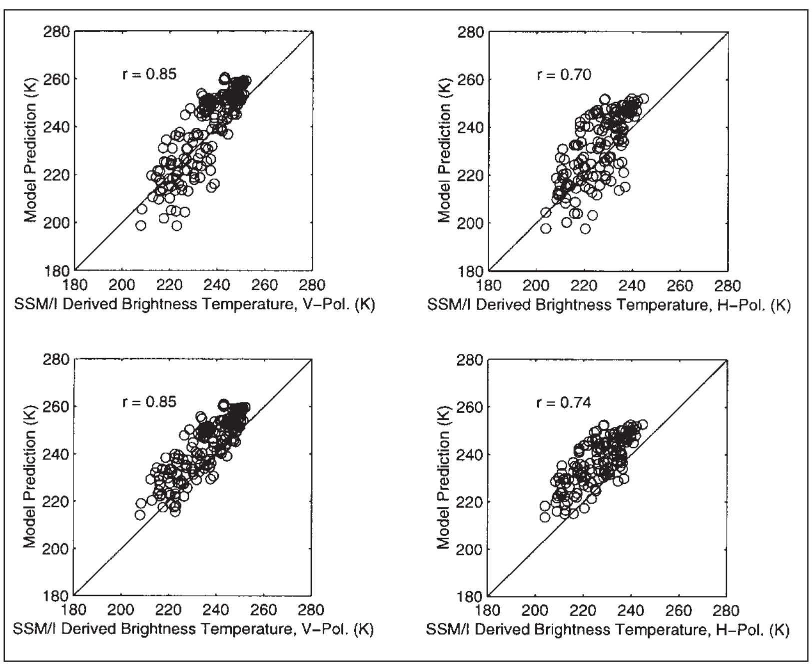


Figure 2: Comparison of SSM/I observations with the HUT snow emission model predictions. The observations and predictions for all SSM/I frequencies are combined. In-situ snow water equivalent, snow density, forest/land cover and air temperature information are used as model input. Snow grain size is modeled as a fixed value of 1.1 mm.
Top: Comparison using balloon sounding-based in-situ atmosphere profiles.
Bottom: Comparison using statistical atmosphere model (Pulliainen et al. 1993).

tion of snow grain size and frequency (Hallikainen et al. 1987), whereas the forward scattering factor is approximated to be a constant coefficient. The effects of forest canopy, soil surface roughness and the atmosphere on the brightness temperature are considered by using empirical/semi-empirical formulas (Kurvonen and Hallikainen 1997, Kruopis et al. 1999, Wegmüller and Mätzler 1999, Pulliainen et al. 1993). A schematic presentation of the main emission contributions is shown in Figure 1. The inclusion of vegetation and atmospheric emission contributions in modeling enables the use of the HUT model for interpreting space-borne radiometer observations. Comparisons of the HUT emission model predictions with independent experimental snowpack emission data and space-borne SSM/I observations show good general agreement (Pulliainen et al. 1999). An example of a comparison with space-borne SSM/I observations is shown in Figure 2. The HUT snow emission model is simple, and therefore useful for direct retrievals of the water equivalent in snowpacks that are not strongly stratified. Care has to be taken at high frequencies (e.g. 90 GHz) where the penetration depth is often smaller than the snow depth. The single-layer model will then be unable to account for vertical gradients of snowpack properties.

The Microwave Emission Model of Layered Snowpacks (MEMLS)

MEMLS is based on radiative transfer, using a correlation-function approach to quantify snow structure, including multiple scattering both by stratification and by snow grains, refraction and radiation trapping by total internal reflection and a combination of coherent and incoherent superpositions of interface reflections (Wiesmann and Mätzler, 1999). The geometry of the snowpack consisting of n ($n \geq 1$) layers is illustrated in Figure 3. This model was achieved following detailed studies of single snow layers by Weise (1996a,b) and Wiesmann et al. (1998a). They found an empirical relationship between the scattering coefficient γ_s, frequency f and correlation length p_{ec}. This relationship was implemented in MEMLS; it is similar to Rayleigh scattering ($\gamma_s \sim f^4 p_{ec}^{\,3}$) with respect to the correlation length, i.e. proportional to $p_{ec}^{\,2.5}$. The measured exponent of f is clearly below 4; it is actually near 2.5. A limitation of the empirical fits for γ_s is in the applicable range of the observed frequencies (5 to 100 GHz), densities

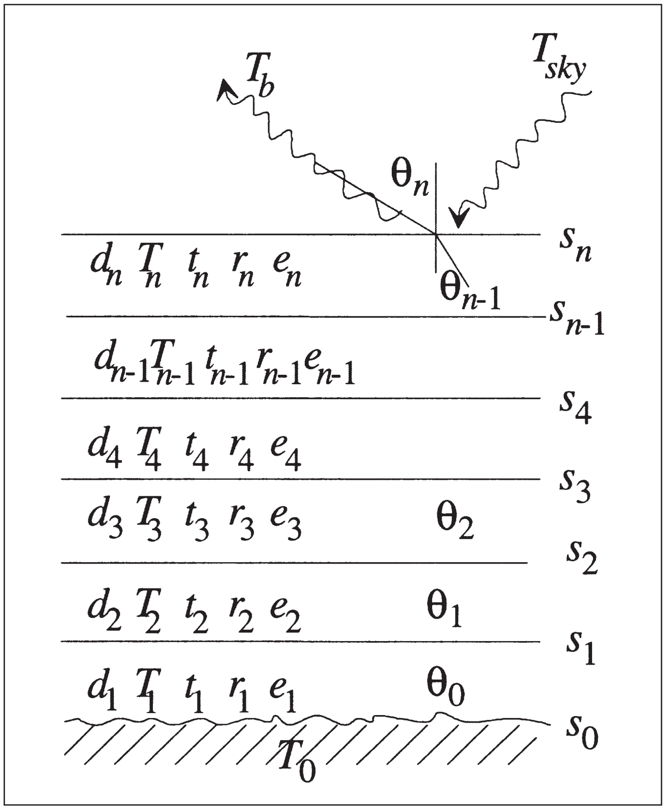


Figure 3: Geometry and parameters of the n*-layer snowpack assumed in MEMLS;* T_b *is the scene brightness (model output) observed in direction* θ_n*, and* T_{sky} *is the sky brightness.*

(0.1 to 0.4 g/cm^3) and correlation lengths (0.05 to 0.3 mm), i.e. the situations found in dry winter snow.

In order to extend MEMLS, especially to coarse-grained snow, a physical model of volume scattering was developed by Mätzler and Wiesmann (1999), based on the improved Born approximation (Mätzler, 1998). An exponential spatial autocorrelation function was selected and found to be reasonable. With this addition, MEMLS obtained a complete physically-based model. The extended model is devoid of free parameters. Model validation included radiometric snow-samples of Wiesmann et al. (1998) on black-body and on metal plates, as well as coarse-grained crusts growing and decaying during melt-and-refreeze cycles. In all cases studied so far, i.e. for correlation lengths up to 0.7 mm, the model showed good agreement with the observations.

Combination of microwave and physical snowcover models

A handicap of microwave emission models is that the number of input parameters is sometimes large. The overall quality of the simulations depends on the accuracy of these parameters, especially when the involved medium is complex. Up to now ground-truth measurements have been used to provide the input. However, some parameters are difficult to collect. An alternative is to derive the snowpack data from physical snowcover models. They describe the properties of the snow cover from standard meteorological observations. These models have been developed to predict the mechanical, thermal, and optical snow properties for various applications, such as climate modeling, avalanche forecasting, and hydrology. The combination of such models with radiative–transfer models is a necessary step in the problem of closure of surface effects in numerical weather prediction and data assimilation. In addition the combination is needed in the validation of both types of models. Furthermore, the detailed sets of required input parameters needed for realistic radiative-transfer computations can – in operational tasks – only be provided by such combinations.

Several groups published recent research in this field: Shih et al. (1997) published a model to calculate backscattering from layered snowpacks, based on dense medium radiative transfer in combination with SNTHERM, a snow physical model to be explained below. Galantowicz and England (1997) presented a passive microwave model in combination with a soil-vegetation-atmosphere scheme based on the physical snow model of Anderson (1975). Wilson et al. (1999) combined a single-layer dry-snow emission model with a hydrological snowpack model derived from SNTHERM and applied it to an area in Colorado. Wiesmann et al. (1998b) developed and tested interfaces to combine MEMLS with two different models, CROCUS and SNTHERM. SNTHERM is a one-dimensional mass and energy balance model, developed at the U.S. Army Cold

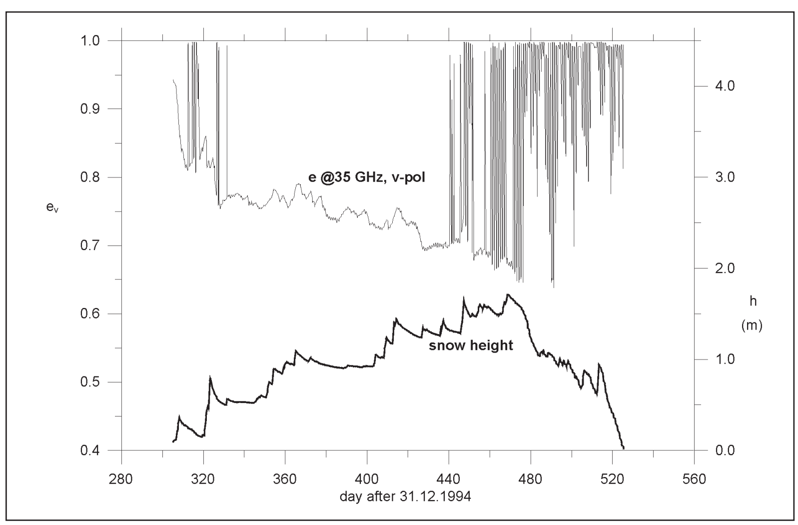


Figure 4: Variation of snow height h *and snowpack emissivity* e_v *at 35 GHz, vertical polarization, during the snow season 1995/96 at the test site, Weissfluhjoch-Davos. The emissivity was simulated by the combined use of CROCUS and MEMLS from standard meteorological observations.*

Regions Research and Engineering Laboratory (CRREL) for predicting temperature profiles within the snow and frozen soil. The model is formulated to describe snow cover over soil with high vertical and temporal resolution. CROCUS is a one-dimensional numerical energy and mass evolution model of snowcovers developed at *Météo France*. Its main objective is operational avalanche forecasting. Both models use meteorological data versus time as input. The output of both models can be used almost directly as input in MEMLS. Only the different descriptions of snow structure had to be adapted to the correlation length used in MEMLS. An example of a combined simulation at 35 GHz is shown in Figure 4. The strong emissivity fluctuations found early and late in the snow season are due to -melt-refreeze cycles. During the dry-snow phase an inverse correlation of the emissivity with snow height can be recognized in the long-term behavior; the short-term variations, however, are uncorrelated. The results obtained so far with both, CROCUS and SNTHERM, indicate reasonable agreement between the combined model and the observations. Discrepancies are observed in the polarization difference, T_v-T_h, which is often underestimated. This is due to the fact that the physical snowpack models cannot simulate the crusts (SNTHERM) or that their density is underestimated (CROCUS).

Outlook: Applications and further improvements

The HUT Model can be used to model snowpack emission including contributions from snow, soil, forest canopies and the atmosphere. It has the potential to be applied for the retrieval of information concerning snow water equivalent (SWE) for dry snow, extent of dry snow cover, onset of snow melt, and information on snow grain size and density.

The investigations carried out to date show promising SWE retrieval accuracies when the HUT model is directly applied to SSM/I observations using a multi-parameter constrained iterative inversion procedure. For example, the areal SWE of the 50,000 km^2-sized River Kemijoki drainage area was estimated with an overall RMSE of 24 mm for a single winter. The corresponding coefficient of determination (r^2) was 0.92, where 30 reference observations were available for comparison. These results were obtained under dry snow conditions (period from 1 Nov. 1993 to 31 March 1994) without using any training reference data.

MEMLS is useful to investigate the influence of snow parameters on the microwave signal and therefore is a tool to analyze microwave data of snow and to develop new snow characterization algorithms. It is also helpful for designing new radiometer systems. Furthermore MEMLS can become a key for new developments in snow physics. Some steps for future work are outlined here:

- To assess the sensitivity of MEMLS to special parameter variations, weighting functions can be computed. The weighting functions are defined by $w_{ij} = \partial e_p/\partial x_{ij}$, where e_p is the emis- sivity at polarization p and x_{ij} is the i^{th} physical parameter of layer j.

- The assumption of an isotropic and exponential correlation function is not valid in general, but so far, it has been a reasonable simplification of snow structure. By including the occasional snow-structure anisotropy (e.g. observed in new snow deposited under calm- wind conditions, surface hoar, depth hoar) the model can be improved, especially in its polarization behavior at frequencies above 30 GHz.

- Multiple versus single layer: It has been argued that single-layer snow emission models are more practical and thus more feasible than multi-layer models. This statement may be tested by simulations using MEMLS for different values of n. MEMLS is adaptive with respect to n. Nevertheless it should be pointed out that layering is inherent in many snowpacks exhibiting signatures revealed by microwave radiometry.

- A combination of SAFRAN/CROCUS (Durand et al., 1993) with MEMLS makes it possible to simulate brightness temperature maps. SAFRAN (Système d'Analyse Fournissant des Renseignements Atmosphériques à la Neige) is a sophisticated meteorological model, calculating the input variables for snow cover simulations in a model topography over large areas (about 1000 km^2). Comparison of such maps with observed data makes it possible to validate forecasts on a large scale. On a local scale it may help to assess snowpack and background properties.

- Using past meteorological information, it is possible to simulate the emissivity of past conditions, providing a tool for reanalyzing historical satellite data. This application is needed for model validation, and furthermore opens the way to climate studies using different observational systems.

- With accurate knowledge of the surface emissivity, it is possible to determine atmospheric parameters from space-based observations.

- Due to the high sensitivity of microwave emission to internal snow-structure parameters, MEMLS can help to improve the snow physical models, especially the quantitative understanding of snow metamorphosis and layer structure. As a feedback of such studies, MEMLS will also be further improved.

3 Recommended Microwave Emission Models for Snowpacks

Physical model: MEMLS

Described by Wiesmann and Mätzler (1999), extended by Mätzler and Wiesmann (1999), Wiesmann et al. (1998b).

Purpose of the model	MEMLS computes transmissivity t_p, emissivity e_p and brightness temperature T_p at polarization p of a snow-covered surface under given illumination by Tsky.
Applications, constraints	Seasonal and perennial snowpacks of any thickness with defined stratigraphy. Assimilation of T_p for NWP, avalanche forecasts, hydrology, climatology, simulation of T_p for sensitivity studies, as a source for construction of simple models and inversion algorithms for snow parameters and ground temperature. Constraints to be assessed.
Model variables and ranges	Frequency range f: 5 to 100 GHz, incidence angle θ: 0 to 60°, polarization: linear h or v
Input parameters, including applicable ranges, options for selection and potential sources	Sky brightness temperature T_{sky} (unlimited), ground temperature T_0, ground-snow interface reflectivity s_0 (0 to 1), for each of the n ($\geq$1) snow layers the following model parameters: Correlation length p_{ec}: 0 to 0.7 mm, temperature T: 100 to 273.15 K, snow density ρ: 50 to 500 kg/m^3, (possibly up to 900 kg/m^3) volumetric liquid-water content s: 0 to about 0.15. Input parameters can be generated by physical snowpack models and meteorological information (Wiesmann et al. 1998b).
Output parameters	Standard: upwelling brightness temperature T_p above the surface Optional: scene emissivity (0 to 1), snowpack transmissivity (0 to 1)
Expected errors	Validation performed for various snow conditions (Wiesmann et al. 1998a; Wiesmann and Mätzler, 1999; Mätzler and Wiesmann, 1999) Present estimate: for T_p: $\leq$ 10 K, for e_p: $\leq$ 0.03 K
Accuracy requirements	Useful: for T_p: 10 K, for e_p: 0.03 K; further assessment needed Adequate: for T_p: 3 K, for e_p: 0.01 K
Further developments	Weighting functions, $w_{ij} = \partial e_p / \partial x_{ij}$, where x_{ij} is the i^{th} physical parameter of layer j, can be computed in order to assess the sensitivity of the model to special parameter variations. Isotropic correlation functions other than exponential can easily be included. More work is needed to account for anisotropic snow structure. Presently the main uncertainty is due to errors in the input parameters. More accurate data on snow structure and better standards are needed.

Semi-empirical model: HUT Model

Described by Pulliainen et al. (1999) and Pulliainen et al. (1998).

Purpose of the model	Computes brightness temperature and emissivity of snow-covered terrain, optionally including the effect of sparse coniferous forest canopy (under winter conditions) and atmosphere
Applications, constraints	Applicable for iterative inversion: snow water equivalent retrieval/monitoring in boreal forest zone (tested and demonstrated). Assimilation in hydrological models to be compared. Potential areas of application: hydrology, meteorology, climatology, hydropower production, flood prediction. Constraints to be assessed.
Model variables and ranges	Frequency: 5 to 100 GHz, nadir angle 20° to 70° (restricted by the soil emission model), polarization: linear h or v
Input parameters (including applicable ranges, options for selection and potential sources)	Sky brightness temperature (unlimited), ground temperature, snow temperature, ground-snow interface reflectivity, effective snow grain size (up to 1.6 mm), snow density (0.1-0.4 g/cm^3). Optionally snow wetness (up to a few percentage units); calculation of ground-snow reflectivity e.g. using the model by Wegmüller and Mätzler (1999); calculation of atmospheric effects, e.g. using the statistical model by Pulliainen et al. 1993.
Output parameters	Brightness temperature and emissivity of snow-covered terrain (above the snow surface). Optionally: airborne or spaceborne observed scene brightness temperature or emissivity including the effect of forest canopy and atmosphere.
Expected errors, validation and quality checks	Validation performed with measurements under experimentally controlled conditions and SSM/I observations. Further error analysis to be done.
Accuracy ranges	To be assessed.
Scope of further development	Currently one empirical parameter (q) included. The behavior of q as function of frequency and snow grain size to be modeled using theoretical approaches. Development of operational snow parameter retrieval methods based on the HUT model.

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"For contributions to and leadership in complex, interdisciplinary remote sensing programs."

Brown, Russell D., Air Force Research Laboratory, Rome, NY
"For contributions to the theory and practice of Wideband Radar Technology."

Das, Yogadhish, Defence Research Establishment Suffield, Medicine Hat, Canada
"For contributions and leadership in electrical techniques of location and identification of buried objects."

Ermert, Helmut, Ruhr University, Bochum, Germany
"For contributions to coherent wave imaging and its application to medical diagnostics and nondestructive testing, and to engineering education."

Farina, Alfonso, ALENIA Systems, Rome, Italy
"For the development and application of adaptive signal processing methods for radar systems."

Freeman, Anthony, JPL, Pasadena, CA
"For contributions to SAR data calibration and development of SAR image products."

Griffiths, Hugh D., University College, London, UK
"For contributions to Synthetic Aperture Radar (SAR), Interferometric SAR, and Sonar."

Pei, Soo-Chang, National Taiwan University, Taipei
"For contributions to the development of digital eigenfilter design, color image coding and signal compression, and to electrical engineering education in Taiwan."

Sarabandi, Kamal, University of Michigan
"For contributions to the modeling of radar remote sensing, and to establish the connections between the incoherent and coherent domains of radar polarimetry."

Schuler, Dale L., Naval Research Laboratory, Washington, DC
"For contributions to the development of coherent multi-frequency microwave sensor and polarimetric SAR techniques for the remote sensing of geophysical parameters on both the ocean and the land."

Sieber, Alois Josef, ISPRA, Italy
"For contributions to and leadership in microwave remote sensing."

SDRS: Software-Defined Radar Sensors

Werner Wiesbeck

Introduction

Recent advances in RF, microwave, digital and software technology will allow the development of software-defined radar sensors (SDRS) in the near future. The functionality and system parameters of radar sensors for remote sensing applications will no longer be implemented in hardware, but instead in downloadable software. Software-defined SAR (SD-SAR) is especially suited for these developments. In this short article, I will outline the envisioned functionality, structure and features of software-defined radar sensors. The vision is not new: Connect the antenna output to an A/D converter and process the signals digitally. This vision may now become possible and extend far beyond what was previously imagined. Synthetic aperture radar is an especially appropriate candidate to explain and demonstrate the future.

The Transmit Subsystem

Let's start with the transmit subsystem. Currently transmit subsystems are mainly implemented using one of the following principles:

- Pulsed-FM synthesizer - high power amplifier - reflector antenna
- Pulsed-FM synthesizer - high power amplifier - beam forming network - fixed array
- Pulsed-FM synthesizer - feed network - transmit/receive modules - radiating elements

The first two of these alternatives are completely inflexible. They seldom allow transmit frequency agility and changes in the radiated beam. Transmit/receive (T/R) modules are typically associated with the use of phased arrays, spot beams and distributed power generation. Several feed or beam-forming networks are required. Spot beams inherently imply loss of coverage, and the overall power efficiency is quite low. The antenna systems have large space and weight requirements, and necessitate large-area solar panels for power generation. Nevertheless, SAR-systems with T/R modules are the best available with the present technology and will continue to be launched during the next few years.

The vision of the future is that radar and synthetic aperture transmitters will be implemented as arrays of modules, each one composed of:

- DDS - up-converter - medium power amplifier - antenna (DDS = direct digital synthesizer)

DDSs are now available on the market with frequencies up to almost 1 GHz, sufficiently high for most applications. They can generate nearly any arbitrary waveform and provide full versatility in amplitude, phase, and spectrum. Complex waveforms can be generated with FM, PM, or AM modulation as well as with coding schemes such as pseudonoise (PN), CDMA, etc. Even multi-carrier waveforms are possible, all selected using only downloadable software. Spectrally efficient modulation and convolutional codes are of special interest. The SDRS implementation makes sensor transmitters highly flexible and modular. Using an up-converter, the DDS frequency range can be transposed to any frequency band used by SAR for remote sensing. The limiting components will be the medium power amplifier and the antenna elements. Using wideband components (antennas, mixers, amplifiers, etc.), a wide variety of spectral transmit modes, e.g. narrowband, wideband, and multicarrier, are possible. In the same manner single-beam, wide-beam, spot-beam, and multi-beam are possible. Because of modularity, transmitters of different sizes as well as with a different number of elements can easily be configured. Baseband signals, control and power supply lines are the only connections to each module. Conformal schemes and adaptation to satellites, aircraft and other platforms are more readily realizable.

The Receive Subsystem

The receivers of software defined radar sensors have similar configurations and structures to that of the transmitters. The same antenna may be used by both. The configuration of a single channel is rather simple:

- Antenna - filter - low noise amplifier - downconverter - A/D converter
  (A/D = Analog/Digital)

The entire antenna consists of an array of these channels. The same flexibility that applies to the transmit elements also applies to the receive. Amplitude, phase and, to a limited extent, coupling can be corrected during processing. The restrictions that usually apply to phased arrays will be relaxed, because the coherence and phase relationships will be established during post-processing and calibration. These receive systems will have a lower noise figure than standard phased array receivers, because the phase shifters have been eliminated. The necessity of a down-converter is determined by the available A/D-converter. The digital output of each receiver channel is directly fed to dedicated processors. The processing modes are adapted to the transmit modes by downloadable software and can be modified with changes in the sensor/target positions, the required specifications in resolution, and the depth of processing. Radar engineers can learn a great deal from their communications colleagues who realize similar concepts for software-defined radios (SDR). In the future, the processing needs for communications are comparable to remote sensing or even higher.

SDRS and SD-SAR System Aspects

Because the entire functionality of this new type of software-defined radar sensors can be downloaded, their operating modes may be multifunctional, selective, active, passive and corrective. In addition to their typical radar function, they may operate as radiometers, for communication or even as electronic warfare transmitters. Several components and subsystems of these envisioned software-defined radar sensors are already under development. Prices and power consumption are still high, but, like those of most digital hardware, they will plummet. Appropriate antennas with excellent features, wide bandwidths, dual polarization and low loss are under development. Digital beam-forming on receive only is one of the top R&D areas for the third and fourth generations of mobile communications. Similarly, multifunctional software-defined radios (SDR), fulfilling the processing needs of different mobile communications standards and services, are under development at many places worldwide. SDRS and SD-SAR will benefit from them.

The future of radar remote sensing hardware will be digital. Several key digital projects in the past have been successful. The functionality of software defined sensors will be downloaded or stored according to the actual requirements. Because of their modular structure, these systems will be more readily available, with shorter production times and far lower prices. Software-defined radar sensors will make microwave remote sensing more affordable in the future. The functionality may even be user-implemented. One should not be afraid of this dramatic yet expected change in our research field in the future. There will be still the need for scientists, RF, microwave, digital and software engineers. Also required will be antennas, microwave semiconductors, digital hardware and software, and last but not least, platform development.

I would like to encourage you to document your contributions to the future of remote sensing in our GRSS Transactions and the IGARSS Conferences. A TGARS Special Issue may be an appropriate forum for these developments.

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- To gather an international group of scientists and engineers from industry, government, and academia whose primary interests include microwave radiometer calibration
- To provide a forum for the dissemination and discussion of the state-of-the-art in radiometer calibration methodologies and technologies
- To identify future calibration requirements to serve as a guide for the research efforts of the microwave radiometer calibration community.

Format and suggested topics

- calibration requirements and error budget analysis
- standard terminology and techniques
- applications demanding improved calibration
- calibration reference design and analysis
- calibration facilities
- calibration and validation of spaceborne sensors using airborne sensors
- calibration (and associated design) of
  — polarimeters
  — real aperture systems
  — interferometers
  — spaceborne sensors
  — airborne sensors
  — ground-based sensors

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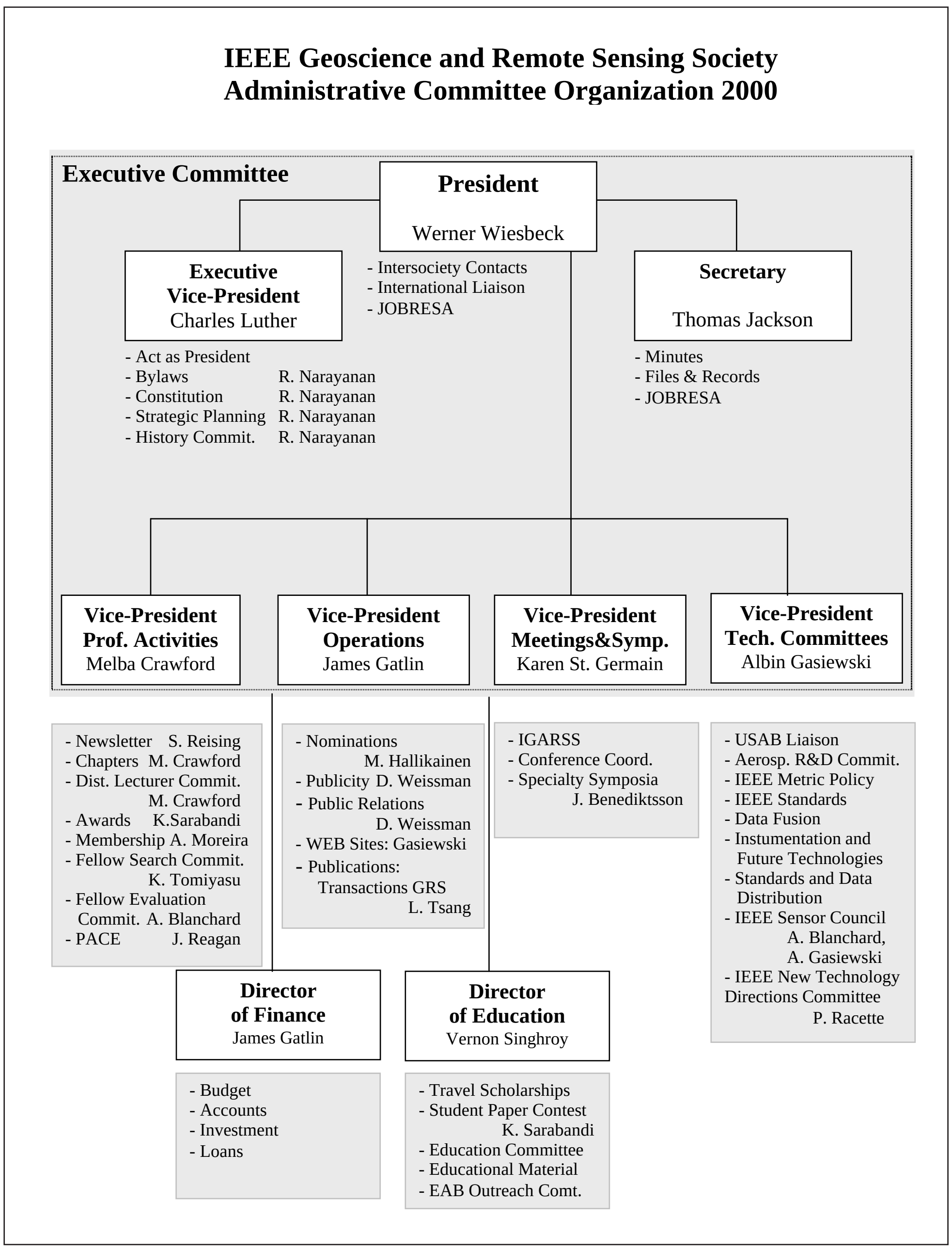
Organization of the GRS-S Administrative Committee

Large organizations like the IEEE with over 300,000 members and involving numerous entities such as Major Boards, IEEE Staff, Regions, Sections, Chapters, Societies, Councils, Conferences, Committees, etc., are difficult to comprehend at first glance. On the other hand, the organization of the Administrative Committee of the relatively small IEEE Geoscience and Remote Sensing Society is easier to understand.

In the following I will attempt to explain how the Administrative Committee (AdCom) is organized. According to our Constitution there are presently no less than twelve and no more than fifteen AdCom members elected by the GRS-S Membership, as well as the Director of Finance and the GRS Transactions Editor. Additionally, there are one or two Past Presidents and other Ex Officio members without vote. The AdCom has numerous duties, in addition to our IGARSS and Transactions. Specific tasks are assigned to each AdCom member. The major tasks or groups of activities are the responsibility of the Vice Presidents, as shown in the diagram below. The Executive Committee consists of the four Vice Presidents, along with the Executive Vice President, the Secretary and the President. The Executive Committee acts on behalf of the AdCom between its meetings. The GRS-S AdCom typically meets three times a year, in mid-February, at IGARSS during the summer and again in mid-November. The term of an AdCom member is normally three years. New members usually are responsible for one or two duties. As they become more familiar with the overall AdCom functions, they may become Vice President after nomination by the President and election by the AdCom. The Executive Vice President and the President are elected for one year terms and are usually re-elected for a second year.

If you look at the organization diagram again and find one or more activities that matches your interests, you may contact any member of the AdCom directly. The complete addresses are given on p. 5 of each GRS-S Newsletter. The Society relies on its members to be active. If you are interested in contributing to the AdCom, you may approach one of the AdCom Members. The Nominations Committee is presently led by Martti Hallikainen, who submits a list of candidates for election. If you have any further or detailed questions I refer you to our GRS-S Constitution and Bylaws.



IGARSS 2000 Camera Ready

IGARSS Camera Ready

Upcoming Conferences

(continued from page 32)

Name: **Joint Multi-sensor Mine Signature Measurement Campaign**
Dates: Starts August 2000
Contact: Patrick Verlinde
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Belgium
Tel.: +32 (2) 737.66.29
Fax: +32 (2) 737.66.22
Email: verlinde@elec.rma.ac.be
URL: http://demining.jrc.it/multi-sensor/index.htm

Name: **2000 International Symposium on Antennas and Propagation - ISAP 2000**
Dates: August 22-25, 2000
Location: Fukuoka, Japan
Contact: Dr. Toshio Ihara
Chairperson of ISAP2000 Publicity Committee
CRL/KARC
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Kobe, 651-2401, Japan
Tel.: +81-78-969-2115
Fax: +81-78-969-2119
Email: isap@karc.crl.go.jp

Name: **FLINS'2000, Session on Intelligent Techniques in Satellite Image Processing**
Dates: 28-30 August 2000
Location: Bruges, Belgium
Contact: Mike Nachtegael (Session Organiser)
Department of Applied Mathematics & Computer Science
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B-9000 Gent, Belgium
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Email: mike.nachtegael@rug.ac.be
URL: http://allserv.rug.ac.be/~mnachteg/flins2000

Name: **2000 International Conference on Microwave and Millimeter Wave Technology**
Dates: Sep. 14-16, 2000
Location: Beijing, China
Contact: Professor Fang Min
Chinese Inst. of Electronics
P.O. Box 165
Beijing 100036, China
Tel: (86)-10-68283463
Fax: (86)-10-68283458
Email: shaz@sun.ihep.ac.cn
URL: http://www.cie-china.org/icmmt2000.htm

Name: **2000 IEEE Conference on Electrical Insulation and Dielectric Phenomena**
Dates: October 15-18, 2000
Location: Victoria, British Columbia, CANADA
Contact: Soli S. Bamji
National Research Council of Canada
Rm. 223, Bldg. M-50
1500 Montreal Road
Ottawa, ON K1A OR6 CANADA
Tel: 613-990-4021
Fax: 613-952-9366
EMail: soli.bamji@nrc.ca
URL: http://www.eeel.nist.gov/ceidp

Name: **MicroCal 2000: The First International Microwave Radiometer Calibration Workshop**
Dates: October 30-31, 2000
Location: University of Maryland Inn and Conference Center
Contact: Paul E. Racette
NASA Goddard Space Flight Center
Microwave Instrument Technology Branch, Code 555
Building 19, Room N15
Greenbelt, MD 20771
Tel: (301) 286-4756
Fax: (301) 286-1750
Email: microcal@jazzman.gsfc.nasa.gov
URL: http://mitb.gsfc.nasa.gov/ucal/

UPCOMING CONFERENCES

Name: **PIERS 2000, Progress in Electromagnetics Research Symposium**
Dates: 5-14 July 2000
Location: Cambridge, MA USA
Contact: Hsiu C. Han
MIT Room 26-305
Cambridge, MA 02139 USA
TEL: +1-617-253-5784
EMail: han@mit.edu
URL: http://www.piers.org

Name: **2000 IEEE International Symposium on Antennas and Propagation**
Dates: July 16-21, 2000
Location: Doubletree Hotel, Salt Lake City, UT USA
Contact: Michael A. Jensen
Dept. of ECE, 459 Clyde Bldg.
Brigham Young University
Provo, UT 84602-4099
EMail: tpc2000@ee.byu.edu
URL: http://www.caeme.elen.utah.edu/aps2000

Name: **SCI'2000, 4th World Multiconference on Systemics, Cybernetics and Informatics**
Dates: 23-26 July 2000
Location: Sheraton World; Orlando, FL USA
Contact: Prof. Nagib Callaos (General Chair)
Fax: 407-856-6274
EMail: nacallao@telcel.net.ve
URL: http://www.iiis.org/isas/

Name: **ISAF 2000, 12th IEEE International Symposium on the Applications of Ferroelectronics**
Dates: 30 July - 2 August 2000
Location: Hilton Hawaiian Village; Honolulu, HI USA
Contact: Angus Kingon (General Chair)
URL: http://www2.ncsu.edu/unity/lockers.profect/isaf_2000/

Name: **International Symposium on Optical Science and Technology**
Dates: 30 July - 4 August 2000
Location: San Diego Convention Center
Chairman: Warren J, Smith
Kaiser Electro-Optics Inc.
Contact: SPIE,
PO Box 10
Bellingham, WA 98227-0010
TEL: (360) 676-3290
Email: annualmeeting@spie.org
URL: http://www.spie.org/info/annualmeeting

Name: **2000 5th International Symposium on Antennas, Propagation and EMTheory - ISAPE 2000**
Dates: August 15-18, 2000
Location: Beijing, China
Contact: Mr. Meng-Qi Zhou
P.O. Box 165
Beijing 100036, China
Tel: (86)-10-6828-3463
Fax: (86)-10-6828-3458
Email: mqzhou@public.bta.net.cn
URL: http://www.cie-china.org/isape-2000.htm

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