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GEOSCIENCE and REMOTE SENSING
Newsletter

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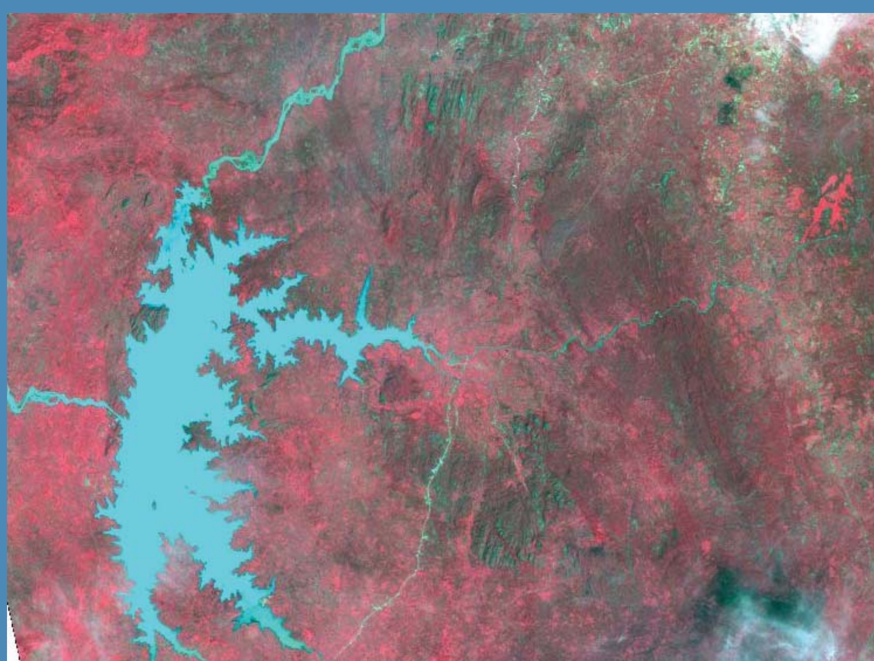
Editor: Adriano Camps



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IEEE

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Newsletter Input and Deadlines

The following is the schedule for the GRS-S 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.

GRS-S Newsletter Schedule

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

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This is a very exciting issue to me. In addition to our regular sections, several of my goals when I became the Editor of this Newsletter have become a reality.

Our editorial board has increased with a new ***Associate Editor for African Affairs***: Mrs. Tariro Charakupa-Chingono. We give her a warm welcome, and we are sure that she will better connect with the interests and activities carried out in the African continent. In this her first issue as Associate Editor, she brings us an article of the third African satellite and its applications, the NigeriaSat-1, which is also in the cover page of this issue.

A new profile is inaugurated: the ***Students Profile***, which is intended to be a place where students and student associations that work in the field of Remote Sensing and closely related areas, can show the community their activities. In this issue the ***AESS Studiants*** association, now trying to form a joint

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Message from the President

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Every five years the Institute performs a thorough review of its Societies and their publications. Having stepped into the Presidency of the GRS-S at the time of our most recent review, I was required to prepare an extensive set of slides covering all aspects of our Society – Awards, Bylaws, Chapters, Demographics, Educational Programs, Fields of Interest, etc… The material was compiled with the help of many of our Society officers and presented to the IEEE Society and Publications Review Boards at the TAB meeting in Savannah, Georgia, on February 12. Our presentation team consisted of Past President Charles Luther, TGARS Editor Jon Benediktsson, Finance Director James Gatlin, and me. While the official results of the review are pending (and I anticipate them to be positive), I would like to share with you some of the key strengths of the GRS-S that became readily apparent during our presentation.

First and foremost, our Society can claim a nearly unique attribute within the Institute in its being a truly global IEEE entity. The global nature of the GRS-S is clear from our demographics, the venues of our IGARSS and Specialty Symposia, our chapter locations, and (perhaps foremost) our intellectual products. Our Society draws its membership from 71 countries located in all 10 IEEE regions, with nearly half of our membership being non-U.S. Reflecting these statistics, just under half (11 out of 23) of our IGARSS events have been held at venues outside of North America, and almost half (9 out of 19) of our Society Chapters are located outside North America. A glance through nearly any issue of TGARS reveals papers on global Earth observations from any of several satellite systems. Many of these papers claim international co-authorship. With regard to global participation, we are one of the most progressive of IEEE Societies.

But our global nature is more than mere "window dressing." This attribute of our Society, I believe, is one of the principle reasons for our strong and evolving technical knowledge base. The GRS-S network of peers is extensive and connects with the best and brightest of

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Cover Figure Information

NigeriaSat-1 at RAL (UK) during testing. NigeriaSat-1 sample imagery: Lagos Coastine and Shiroro Dam (Nigeria).

NigeriaSat-1 was launched at 7:12 hours on 27 September, 2003 from the Plesetsk Launching Pad in Northern Russia. It is a satellite of the standard Disaster Monitoring Constellation (DMC) design carrying an optical imaging payload developed by SSTL (Surrey Satellite Technologies Ltd.) to provide 32-m ground resolution with an exceptionally wide swath width of over 640 km. The payload uses green, red and near infrared bands equivalent to Landsat TM+ bands 2, 3 and 4. Images are stored in a 1-gigabyte solid-state data recorder and returned via an 8-Mbps S-band downlink. NigeriaSat-1 can image scenes as large as 640 x 560 km, providing unparalleled wide-area, medium-resolution data. The data will be used within Nigeria to monitor pollution, land use and other medium-scale phenomena. See article for more details.

Editor's Comments

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GRS-S/AESS/AP/MTT student chapter, presents its activities at the Technical University of Catalonia. From here, we would like to invite other student associations to submit their short manuscripts.

Finally, the section on ***Short Tutorials*** has started with a very interesting introductory tutorial on radar polarimetry and interferometry, by Dr. Shane Cloude. We are very grateful to Dr. Cloude for the time and the dedication spent in preparing this short tutorial. As we expect to continue this series of short tutorials in future issues of the Newsletter, please do not hesitate to contact the Editorial Board if you want to contribute. These introductory manuscripts are more oriented to undergraduate students on Remote Sensing, the seed of the future of our community and society, or to professionals working in a different field willing to know more about it.

Hope you enjoy it!

Introducing Our New Editorial Board Member

Mrs. Tariro Charakupa-Chingono, was born in 1967 in Zimbabwe. She received a Meteorological Officer 4 Certificate in 1989 from the Meteorological Office of Zimbabwe, the Diploma on Geological Technology for Environmental Management in 1993 from the University of Luton (UK), the Bachelor of Science in Environment Geology in 1995 from the Royal Holloway University of London, and the Masters of Science in 1996 in Remote Sensing and Geographical Information Systems for Environmental Management from the University of Greenwich (UK). From 1987 to 1991 she was a Junior Meterological Officer at the Zimbabwe Meteorological Office, and from 1996 to 2002 a research Scientist/Consultant in the Environment and Remote Sensing Institute. Since 2002 she is a Geoenvironmental Consultant, GIS and Remote Sensing Specialist at Aqualogic Gaborone, and since 2003 a Research Associate at the Institute of Environmental Studies, at the University of Zimbabwe. Her current interest embrace consultancy, training and research in the application of integrated remote sensing and GIS for resource exploration, monitoring and management, environmental monitoring and management including waste management, pollution monitoring and management (groundwater and land surface), environmental impact assessment (EIA), and waste management. She is an active member of the Commission on Geological Sciences for Environmental Planning of the international Union of Geological Sciences (co-geoenvironment - the Medical Geology/Geomedicine Working Group), the Southern African Network for Training in the Environment (SANTREN), the Air Pollution Network for Africa (APINA), and the Association of Geoscientists for International Development (AGID).

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GRS-S Members Elevated to the Grade of Senior Member from June 2003 to March 2004

Congratulations to the following 32 IEEE GRS-S members who were elevated to the Senior membership grade during the period June 2003 to March 2004. Their names and dates of elevation are listed below.

June 03: H. Ramapriyan, R. C. Poe, M. D. King, M. M. Verstraete, P. Cipollini
August 03: E. L. Miller, S.T. K. Chan, V. Jandhyala, D. A. Clausi, S. Masanobu
October 03: G. M. Skofronick Jackson, D. B. Trizna, G. L. Rochon, S. Li, M. T. Chahine, M. R. B. Dunsmore, M. Xia, T. W.S. Chow
November 03: S. Qian, M. O. Sigelle, S. R. J. Axelsson, S. Cruz-Pol, L. L. Yan
January 04: J. V. Toporkov, M. Nolan, Y. Xue, X. Zhang
February 04: T. Kane, G. S. Percivall, S. Pookaiyaudom, F. L. Teixeira, Z. Wu

Senior membership has the following distinct benefits:

- The professional recognition of your peers for technical and professional excellence.
- An attractive fine wood and bronze engraved Señor Member plaque to proudly display.
- Up to $25.00 gift certificate toward one new Society membership.
- A letter of commendation to your employer on the achievement of Senior member grade (upon request of the newly elected Senior Member).
- Announcement of elevation in Section/Society and/or local newsletters, newspapers and notices.
- Eligibility to hold executive IEEE volunteer positions.
- Can serve as Reference for Senior Member applicants.
- Invited to be on the panel to review Senior Member applications.
- Eligible for election to be an IEEE Fellow.

Applications for senior membership can be obtained form IEEE GRS-S website:
http://ewh.ieee.org/soc/grss/ (click Join Us)
or IEEE Senior membership program:
http://www.ieee.org/organizations/rab/md/smprogram.html

IEEE Dennis J. Picard Medal for Radar Technologies and Applications Sponsored by: Raytheon Company

The IEEE Dennis J. Picard Medal for Radar Technologies and Applications was established in 1999 for outstanding accomplishments in advancing the fields of radar technologies to an individual or group of up to three, Recipient selection is administered by the IEEE Awards Board through its Medals Council. A Picard Medal Evaluation Committee, consisting of representatives from the IEEE Societies, reviews nominations and forwards a recommendation to the Medals Council. Criteria considered by the Evaluation Committee include leadership in the field of radar technologies and applications; originality, breadth, inventive value and duration of individual and/or group contributions; publications and patents; society activities and awards; industry recognition and honors; and nomination quality. The award consists of a gold medal, certificate and a cash prize.

Information on the Medal and the nomination forms may be found at: http://www.ieee.org/awards/sums/picard.xml

Nomination Deadline: 1 July, 2004

Prior recipients of the award

2004 - DAVID ATLAS, Distinguished Visiting Scientist NASA Goddard Space Flight Center Greenbelt, MD
"For exceptionally outstanding leadership and significant individual technical contributions to the application of radar for the observation of weather and other atmospheric phenomena."

2003 - WILLIAM SKILLMAN Consultant, (Retired) Westinghouse Electric Baltimore, MD
"For pioneering work in pulse Doppler radar design and its utilization for airborne early warning radar systems."

2002 - DAVID K. BARTON, Executive Vice-President, ANRO Engineering Inc., Hudson, MA
"For contributions to radar system design and analysis, the publication of definitive radar reference books, and to the exchange of radar technology information internationally."

2001 - FRITZ STEUDEL, Raytheon Company (retired), Sudbury, MA
"For outstanding leadership, technical contributions and the implementation of innovative concepts in the design, development, and deployment of large wide-band phased array radar systems."

2000 - MERRILL SKOLNIK, Naval Research Laboratory, Washington, D.C.
"For outstanding leadership of Navy radar research, authorship of widely used books on radar, and personal contributions to the advancement of radar technology and systems."

PACE Piece

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Did you know?
IEEE offers a 50% reduction in membership dues to applicants who are unemployed.

In lieu of on interview, in this issue I report on IEEE-USA 2004 Leadership Workshop held March 19-21 in Atlanta Georgia. The Leadership Workshop was an eye opener for me, demonstrating the depth of the grassroots volunteer network that is the life source for the activities of the IEEE-USA. IEEE-USA serves its membership through maintaining professional development programs, career counseling services, and promoting the interests of the membership through legislative activities. In the words of the IEEE-USA president John Steadman, "IEEE-USA is everything but the technical issues." I enjoyed the workshop's keynote address by Dr. Peggy Hutcheson who spoke on volunteer leadership. I share a summary of her presentation in a sidebar article. At this year's workshop, unemployment of the IEEE membership was the focus of much discussion.

Unemployment is Priority Issue for the IEEE-USA

With a US contingency of ~235,000 members, IEEE-USA is an influential lobbying force and the largest technical organization that provides legislatures with advice important to technical policy formulation. The top priority issue for the IEEE-USA is the record high levels of unemployment of electrical and computer engineers across the country. Ron Hira is an electrical engineer and expert in public policy at the Rochester Institute of Technology. He presented statistics of employment trends over the past two decades. Alarming is the fact that for the first time, in 2003 unemployment rate for electrical and electronic engineers reached an all-time annual high of 6.2 percent exceeding the national average unemployment for all workers (see Fig. 1). In response, the IEEE-USA board of Directors has recently approved position statements on the H1-B visa program, L-1 visa, and offshore outsourcing. These position statements as well as others may be viewed on www.ieeeusa.org.

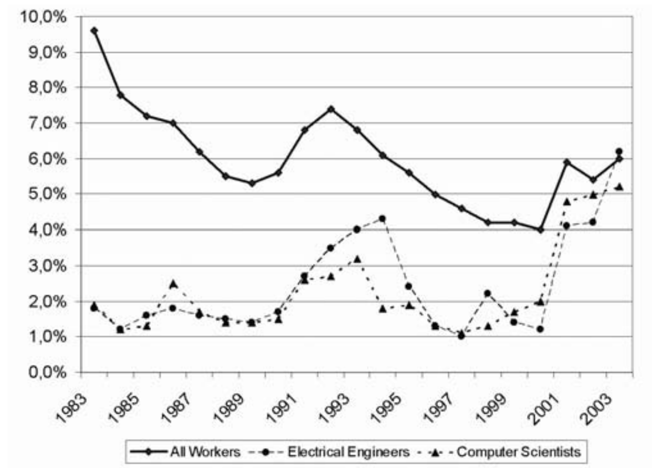

Figure 1: Unemployment rates of electronic engineers and computer scientist over the past two decades compared with total worker unemployment. In 2003, the unemployment rate of electronic engineers exceeded the national rate for all employees.

In addition to position statements related to employment issues, the IEEE_USA board has established the following public policy priorities:

- Promoting research and innovation to sustain US technological leadership
- Enhancing homeland security and protecting critical infrastructure
- Ensuring the reliability of the US electrical power system
- Sustaining a world-class science and engineering workforce
- Promoting savings and safeguarding retirement security
- Supporting US competitiveness through deployment of advanced communications technologies
- Using technology to promote public health and safety

Political activism is one of the most important functions of IEEE-USA. To this end, IEEE-USA employs full-time lobbyists who work on Capitol Hill to promote the interests of engineers. The IEEE-USA staff can help you to develop a strategy to convey your message to congressional leaders. The IEEE-USA website contains a number of resources to assist the political activist. These resources include: a tool that identifies your elected officials for the district in which you live, guidelines for writing your representatives, voter registration forms, and candidate information for upcoming elections. Many GRS-S members may be prohibited from certain lobbying activities, especially in the context of their official work. For this reason, a Review of the Hatch Act is included in this issue.

What every volunteer leader needs to know

Peggy Hutcheson delivered the keynote address for the IEEE-USA Leadership Workshop.

Dr. Peggy Hutcheson, President of The Odyssey Group received a special citation at the IEEE-USA Awards and Recognition Program "For her tireless efforts and devotion to enhancing the careers and professional development of U.S. IEEE members." She was also the keynote speaker at the Leadership Workshop where she spoke on "what every volunteer leader needs to know." Her keynote address resonated with the audience since all the workshop participants were volunteer leaders. She spoke of 10 things she has learned that make a successful volunteer leader:

1. Volunteer for what you are passionate about. You will be effective if you are where you want to make a difference, if you are doing what you enjoy, and you are serving for a cause you care about.
2. Build a collaborative environment in which others can both give and gain based on their interests and goals. It's more important to obtain commitment than agreement…and the more the merrier.
3. Listen, listen, listen. It is important to listen to your group and to hear what is said…and what is not said. Know your listening skills and your own limitations. It's not an accident of nature that we have two ears and one mouth.
4. You can't do it all, so focus on a few key things that will make a difference. Concentrate on pursuing an agenda that is balanced in success and fulfillment.
5. Make it is easy for others to succeed and reward them when they do succeed. Recognition spawns initiative.
6. Over communicate – both about the big stuff and the little stuff. Communicate in multiple ways and about a lot of things including both the good and the bad.
7. Volunteering is volunteer work. Make it more fun than the same old work. Recognize and celebrate the diversity of the group. Food helps and laughter is welcome. Offer variety at your gatherings.
8. Success requires structure and organization. Manage meetings and events, think through the details…and follow up.
9. Be clear about your vision, expectations, results you desire, and what you think it will take to get there. And be realistic.
10. Look for talent and develop it. Coaching and mentoring are important elements of being a leader. Find your successor and prepare him or her.

IEEE GEOSCIENCE AND REMOTE SENSING SOCIETY ANNOUNCES

Geoscience and Remote Sensing Letters (GRSL)

Call For Short Papers

In an effort to reduce the time required to publish shorter topical papers, the IEEE Geoscience and Remote Sensing Society solicits the submission of original papers for Geoscience and Remote Sensing Letters (GRSL). Papers should relate to the theory, concepts, techniques, and applications of remote sensing of the earth (oceans and atmosphere) and space as well as the processing, interpretation, and dissemination of this information. GRSL papers may not exceed 5 pages (single-spaced, two columns with 3-5 figures) in length. Color figures are encouraged, and the author's cost of reproduction will be minimized. Each paper will receive at least 2 reviews. Accepted papers will be published electronically shortly after receipt of final materials at IEEE. GRSL encourages papers addressing new ideas and formative concepts in remote sensing as well as important new and timely results. Links to web pages and online software will be encouraged as a way to include material that is not normally accessible in a journal but is of great value to the remote sensing community.

Procedure:

Prospective authors should submit their manuscripts electronically by going to http://grs-ieee.manuscriptcentral.com and choosing "Geoscience and Remote Sensing Letters" in pulldown menu for choice of Journal. Instructions for creating new user accounts, if necessary, are available on the login screen. Questions concerning the submission process should be addressed to TGRS-L@IEEE.ORG. Inquiries concerning subject material for GRSL should be sent to Bill Emery at emery@colorado.edu.

The African Continent Launches a Third Satellite

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The Nigeria's NigeriaSat-1 launched on a Kosmos-3M booster rocket from the Plesetsk Cosmodrome in Northern Russia on 27th September 2003 is the third African satellite in orbit after the South African and Algerian satellites.

In a group of five other satellites, NigeriaSat–1 will image the country and beam to the ground station satellite images and photographs for use in various areas of socio–economic development (nigeriafirst.org 2004). Each of the six satellites in the Disaster Monitoring Constellation (to which Nigeria has become a member) belongs to one country, but is expected to share information with the others for disaster monitoring. For the rest of the time, each nation can use its satellite as it wishes.

The Disaster Monitoring Constellation (DMC) is a novel international co-operation in space, led by Surrey Satellite Technologies Ltd. (SSTL) bringing together organisations from seven countries: Algeria, China, Nigeria, Thailand, Turkey, the United Kingdom and Vietnam. The DMC Consortium is forming the first-ever micro-satellite constellation bringing remarkable Earth observation capabilities both nationally to the individual satellite owners, and internationally to benefit world-wide humanitarian aid efforts (Gunter Dirk Krebs 2004). Its satellites have all been built by SSTL, a spin-off from the University of Surrey in Guildford, UK (BBC News 2003).

Fifteen fully trained Nigerian scientists and engineers under the supervision of the National Space Research and Development Agency (NSRDA) will run the ground control station in Abuja. Five of the 15 Nigerian engineers and scientists involved in the Nigerian satellite programme were trained at the Centre for Scientific and Industrial Research (CSIR) Satellite Applications Centre (SAC) in South Africa. The scientists and engineers went through an eight-week intensive programme at SAC which included satellite telemetry, tracking and command (controlling the satellite), as well as skills in the use of applying the images that will be captured from the satellite to real world problems (CSIR 2003). The other Nigerian engineers were trained in Britain and were involved in the design and production of the satellite.

Foundation

The NigeriaSat-1 project was conceived in April 1999 with the establishment of the National Space Research and Development Agency (NASRDA). The agency has the mandate to coordinate and consolidate all space technology activities leading to the development of a Nigerian satellite (nigeriafirst.org 2004).

NigeriaSat-1

NigeriaSat-1 is a low Earth orbit micro-satellite weighing 100 kg. It has ground sampling distance (GSD) or spatial resolution of 32m. The device is designed to take images on a ground area of 600 x 570 km. It is built with a camera base system fitted with normalised differential vegetative index (NDVI) technology capable of giving early warning signals of natural and environmental disasters. NigeriaSat-1 can acquire a wide range of data useful for geospatial purposes and produces these data in various formats.

Main Uses of the Satellite

At conception, Nigerian intended to use the satellite for a range of vital humanitarian activities, including disaster management and early warning signals for floods.

Information obtained would assist government to document, plan, evacuate victims, and manage disasters.

- The satellite is also to be used to determine human activities on the environment, identify natural occurrences and their potential areas of spread and damages. This would enable government install appropriate plans to avoid or manage occurrence of disasters such as oil pollution, desertification, erosion, forest fire, and deforestation.
- In agriculture, the NigeriaSat-1 is to be used for mapping, land use planning and management of sustainable grazing, forest logging and planning afforestation programmes. It would also provide data needed for crop inventory and yield forecast.

Other uses of the Satellite include:

- Water resources development and management, including assessment of the quantity and quality of surface and underground water, rainfall prediction, as well as integrated water resources management on drought and other disaster forecast.
- Solid mineral exploration and exploitation, including general geological mapping and map update or revision, as well as differentiating host mineral areas in oil, gas and solid mineral exploration
- Ecosystem, evaluation and monitoring of vegetation and land use as well as the aquatic system
- Local and regional planning for tourism and its potential.
- Scientists from the National Airspace Development Agency say that the satellite is capable of delivering data that would serve demographic uses such as mapping and planning of population surveys, census enumeration areas, as well as mapping, planning and monitoring of rural and urban growth.
- The NigeriaSat-1 satellite project would also be used to map state and international boundaries, plan and map ter-

rain traffic for defence and security purposes, as well as serve as a potent weapon to identify and neutralise international criminals.

- Finally, the NigeriaSat-1 project provides important services in the areas of health and education. It would be used in public health delivery to establish the relationship between malaria vectors and the environment that breeds malaria, as well as to give early warning on future outbreaks of meningitis.
- The satellite is also to provide the technology needed to bring education to all parts of the country via distant learning (nigeriafirst.org 2003).

Further Developments

In a speech read by the Director General of the National Space Research and Development Agency (NASRDA) Professor Robert Boroffice, on behalf of the Minister of Science and Technology Professor Turner Isoun, the plans to launch a second Nigerian satellite in 2006 were announced (Seun Adeoye, Osogbo, 2004). The Minister emphasised the need for better national and international communication through the use of satellite communication tools.

Points of View

However, both the current and planned satellite programmes have provoked controversy in certain sectors. Commentators argue that Nigeria for a country where more than 80million of its population of 126million live in abject poverty ought not to be spending its limited resources on a space programme. On the other hand others, including former Nigerian presidential advisor on space Dr. Ade Abiodun believe that satellites can be an efficient use of public money where they provide timely and vital socio-economic information for decision makers.

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Organizational Profile

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Introduction

Radio waves were first generated by Sir J.C. Bose in India about 100 years ago. At the same time, Sir Marconi also demonstrated the communication with radio waves in Europe. During the past century, with the advent of satellite communications, microwave remote sensing, line of sight communications, troposcatter communications, the generation of radio waves, and its applications have been widely accepted in most of the areas.

During an international conference sponsored by the Union of Radio Science International (URSI) held at Ahemdabad in November 1995, the meeting attendants agreed to setup an International Center for Radio Science in India, and the board objectives were formulated. In a meeting held in New Delhi on May 15th 1996, Prof. O.P.N. Calla was invited to become the First Director (founder Director) of the International Center for Radio Science (ICRS). The ICRS exists as a registered society since June 1997. Its goals are to conduct research, training and teaching in radio science, telecommunication, electronics, computer and information science. The Shri Laxmi Narain Calla Education (L.N.C.E.) foundation was the initial promoter and provider of the funds for initial work. A management council was established with scientists from India, and an international advisory board was set up with scientists from various important laboratories, research organizations, government organizations and academics of different countries: Belgium, Brazil, Canada, Holland, Japan, New Zealand, Nigeria, Russia, and U. K.

Objectives

To enhance the interaction and collaboration within scientists working in the field of Radio Science, the ICRS has the following objectives:

(a) To conduct research and studies in the field of radio, telecommunications, electronics and information science, and within these fields: to promote and organize research with national and international cooperation, and the discussion and dissemination of the research results.

(b) To encourage the adoption of common methods of measurement, inter-comparison, and standardization of measuring instruments used in the scientific work.

(c) To stimulate and coordinate studies on:

Fig. 1. The microwave bench at 8-12 GHz band used for measurement of Dielectric Constant.

- Scientific aspects and application of telecommunications using guided and non-guided electromagnetic waves.
- Scientific aspects of applications of remote sensing using guided and non-guided electromagnetic waves.
- The generation and detection of electromagnetic waves, and the processing of the signals carried by them.
- To study the interaction of radio waves with matter. To find out the effects of radio waves on the living and non-living beings.
- To study, research and develop non-conventional power generation methods.

(d) To create infrastructure commensurate with the need of well-defined programs, as accepted and approved by the competent decision-making body.

(e) To work in close coordination with the concerned national organizations working in the field of radio science.

(f) To collaborate with national and international institutions and organizations with a view to exchange and share academic resources, and attend the hardware and software needs of the Center.

(g) To conduct short and long term courses, training programs as well as other activities in line with the objectives of the Center.

(h) To upgrade and increase the available facilities required to perform research programs.

(i) To consider and implement, at the appropriate time, an extension of the Center facilities in a suitable form for furtherance of its aims and objectives.

(j) To consider and, if found appropriate by the competent body, to allow utilization of the available facilities at similar professional bodies in the terms and conditions that may be decided by the competent authority in view of the overall objectives of the Center.

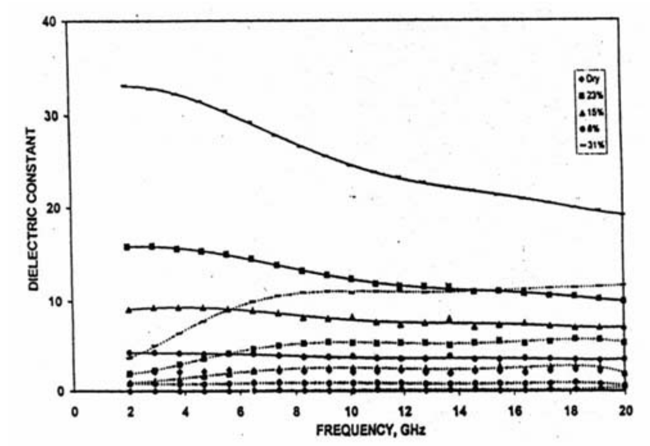

Fig. 2a. Fig. 1 Variation of Dielectric Constant, both e' and e", of dry and wet loamy sandy soil with respect to frequency as well as to different percentage of soil moisture.

(k) To obtain grants, sanctions, and take other appropriate conventional and innovative steps to make the center self-supporting financially.

(l) To purchase and sale the property including land, building, etc. as needed and required by the institution either on lease, or as gift / donation … and also to take on rent as approved by competent decision-making body.

Collaborative Programs

ICRS has collaborative programs with various research institutions as well as with various universities. The centre has signed MoU with Central Electronics Engineering Research Institute (CEERI) -Pilani, S.N. Bose National Center for Basic Sciences – Kolkata, as well as with Tezpur University – Assam, Burdwan University – West Bengal, Jadavpur University – Kolkata, Tripura University – Tripura and Central Arid Zone Research Institute (CAZRI) – Jodhpur. ICRS has also collaborative programs with Defense Laboratory Jodhpur, Jai Narain Vyas University – Jodhpur and S. N. Medical College – Jodhpur.

ICRS has its registered office at "OM NIWAS" A–23, Shastri Nagar, Jodhpur 342 003, and has the following facilities: microwave laboratory, computer facilities, electroplating and electroforming facility borrowed from Calla Engineers, digital signal processing laboratory, and secretariat. There is a provision available for further expansion in facilities.

Field of work

The different areas in which ICRS is working are: 1) electromagnetic metrology, 2) field and waves, 3) signals and systems, 4) electronics and photonics, 5) electromagnetic noise and interference, 6) wave propagation and remote sensing, 7) ionospheric radio and propagation of waves, 8) waves in plasma, 9) radio astronomy, 10) electromagnetic in biology and medicine, 11) information science and technology, 12), computer hardware and

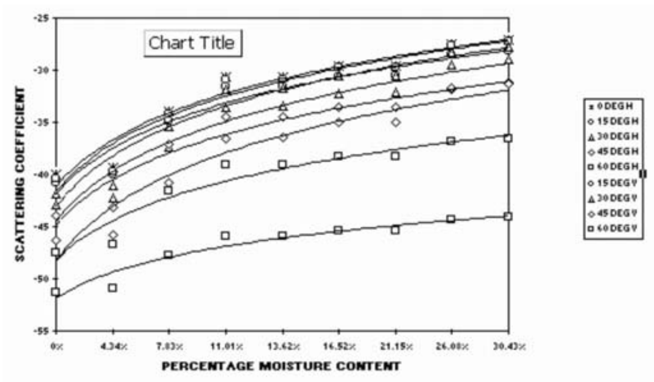

Fig. 2b. Variation of Scattering Coefficient with different percentage moisture content and different angle of incident and polarization at 2 GHz for dry, wet and saline soil.

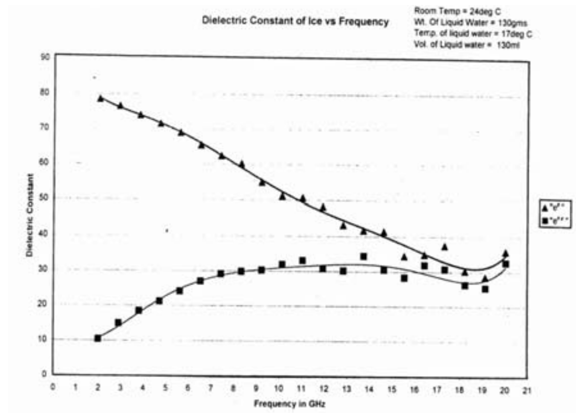

Fig. 2c. Variation of Dielectric Constant of Ice vs. Frequency (2 to 20 GHz)

software, 13) satellite communications, 14) microwave remote sensing, and 15) image processing,

In all these areas, the work leading to the Ph. D. Degree by students and research scientist is carried out in both hardware and applications sides. Jai Narain Vyas University, Jodhpur has also recognized ICRS for Doctorate level, and in last couple of years approximately ten M. Tech. Thesis, and more than ten student projects have been completed at ICRS.

Research

In past six years the ICRS has undertaken activities in the following areas:

1) **Microwave Remote Sensing:** In this area, ICRS has worked in the study of the dielectric constant of dry and wet soil of various locations of India at radio frequencies. The microwave bench at 8-12 GHz band used to measure the dielectric constant is shown in Figure 1. For 2-20 GHz frequency band the network analyzer dielectric probe was used to measure the dielectric constant.

   The emission and scattering characteristics of pure soil or with different salinities, dry or wet, have been studied using the measured values of dielectric constant and with theoretical models. We have also generated a model named Calla-Vivek-Chetan-Gangadhar (CVCG) relating the soil dielectric constant and its physical constituents. The dielectric constant of pure water, or with different salinities, as well as dry and wet ice has been measured from 2 to 20 GHz. The emissivity of foam-covered salt water has also been estimated. The above-mentioned work is explained with some of the graphs and developed images given in Figures 2a-2e. The images have been generated using C++, Java & Matlab [1-7].

   The remote sensing of the vegetation canopy has also been initiated. The dielectric constant of neem leaves has been measured and the emissivity and scattering coefficient have been estimated. In this area, many papers have been published in National and International Conferences around the world by ICRS.

2) **Biomedical Applications:** At ICRS, the work related to the application of Radio Techniques to Biomedical started at very early stage. The attention was drawn to the effect of radiation on the human being. In this direction, an experiment was conducted in collaboration with Dr. S. N. Medical College Jodhpur. The experiment consisted of finding out the effect of microwave radiation on the different parts of the body of guinea pig. The continuous exposure to radiation was studied. The work related to this study was presented in the conferences held at Jodhpur, and was accepted for presentation in URSI General Assembly held at Toronto, Canada, in 1999. The details are as follows:
   - In the 16th annual conference of India Association of Pathologists and Microbiologists held at Jodhpur on November 18th-22nd, 1997.
   - In the 12th National symposium on Radiation Physics held at Defense Laboratory Jodhpur on January 28th-30th, 1998.
   - In the 26th General Assembly of International Union of Radio Science which was held at Toronto Canada on August 13th-21st, 1999.

   The relationship between the sugar content in the blood and the dielectric constant of blood is being studied. The study of the relation of other parameters of blood with dielectric constant will be undertaken.

3) **Antenna and Propagation:** In this area, ICRS has worked in the design of a 140 MHz antenna which has to be small in size and also should have protection from accumulation of snow. Another antenna at S–band has been designed which also is very much small is size. The development of a corner reflector and the measurement of radar cross section (RCS) using Lunenburg lens is also pursued.

   The propagation of radio waves and the effect of rain on the propagation above 10 GHz has been studied as ICRS [8]. Some future work in this direction is being planned, including the study of effect of rain on the propagation from 20 GHz to 30 GHz. The instrumentation that will be used are microwave radiometers and beacon receivers [9].

   Microwave propagation over the sea has also been stud-

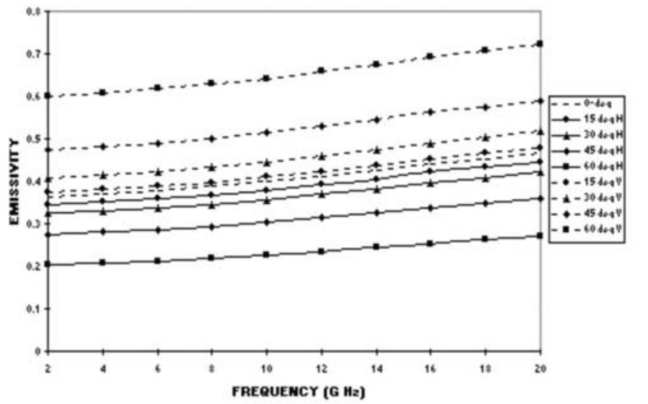

Fig. 2d. Variation of emissivity of pure water with frequency (solid lines are for horizontal, dotted lines are for vertical polarization.)

ied. The signal fading in a line-of-sight link over the sea due to the change in the water level has being studied, establishing the correlation between the time of fade and the water level has been established, and a model using C/C++ has been generated to determine the number of fades for the measured water level at the mainland and an island. The figures and images have been developed in C++, JAVA and MATLAB. Figure 3 shows the graph for the water level and dots are showing number of fades.

4) **Industrial Application:** In this area ICRS is collaborating with Central Electronics Engineering Research Institute PILANI, and Central Fuel Research Institute Dhanbad. One of the activities pursued is the coal desulphurization. ICRS also plans to study effect of microwave radiation to preserve grains and vegetables.
5) **Human Resources Development:** The ICRS is presently working in the field of Human Resources Development. At present, post-graduate students are doing their thesis work at ICRS. Graduate level students are also trained at ICRS. A Training Division for scientist in the Microwave Engineering and Applications is planned for the future. These training programs will be short-term courses of a few weeks and long-term courses for few months. These could be undertaken for sponsored candidates, which could be tailor-made courses for the organizations, which do not have such courses at the entry level for scientists and engineers. Post-doctoral work is also undertaken.

Projects

The Defense, Research and Development Organization, Chandigarh, asked ICRS to prepare a "Feasibility study report on use of microwave instruments for snow study," that has been prepared and submitted. ICRS has also been given following projects by Interim Test Range (ITR), DRDO Chandipur, Electronics and Radar Development Organization (LRDE), DRDO Bangalore and Research Centre Imarat (RCI), DRDO Hyderabad.

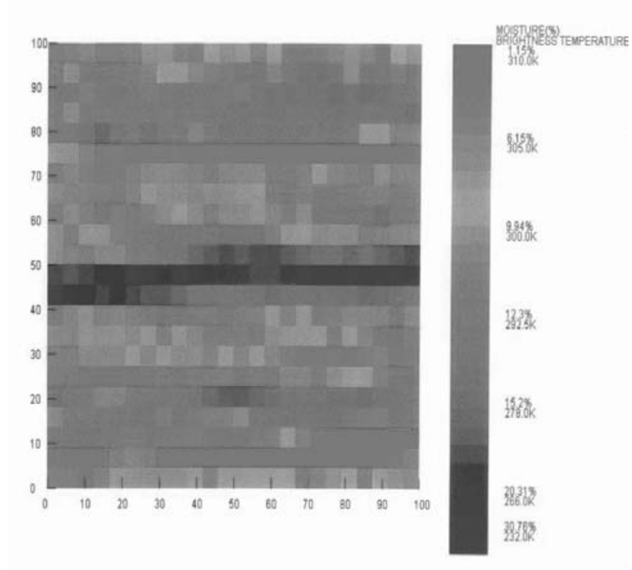

Fig. 2e. Image showing the variation of Brightness Temperature with moisture content (%) for 45-degree angle of incident at vertical polarization.

1. Study of High Resolution Radar
Principal Investigator: Prof. OPN Calla
Research Assistant: Mr. Tapan Borah
Funding Agency: LRDE, DRDO
Duration: April 2002-March 2003
In this project high resolution microwave imaging techniques of radar targets have been studied. Different types of SAR namely generic, spotlight, strip map, circular, and mono-pulse have been studied. Issues related to signal properties, image reconstruction process, and the algorithms used in the image reconstruction of different SAR types (spatial frequency domain interpolation, range stacking, time domain correlation and back-projection method) are analyzed in detail. The steps and issues involved in implementing these algorithms are also discussed at length. The motion compensation issue is also discussed. The images used in the analysis have been generated for an area of terrain assuming a random distribution of moisture using the scattering coefficients that have been estimated using a geometric optics model, the measured dielectric constant and the soil surface parameters.

2. Propagation studies for Line of sight Link over sea
Principal Investigator: Prof. OPN Calla
Research Assistants: Mr. Tapan Borah, Mr. Sandip, Ghosh, Mr. Sanjib Agarwalla, Mr. Dinesh Bohra
Funding Agency: ITR, DRDO
Duration: December 2002-June 2004
The microwave link over sea that connects the mainland and the island has communication failures, which are related to the variability of the water level. The fading of the signal in a line-of-sight link over sea due to the change in the water level is studied. The correlation between the time of fade and the water level has been estab-

lished and the model has been generated to determine the number of fades for the measured water level at mainland and island.

3. Multi-path Studies
Principal Investigator: Prof. OPN Calla
Research Assistants: Mr. Sandip Ghosh, Mr. Sanjib, Agarwalla, Mr. Dinesh Bohra,
Funding Agency: RCI, DRDO
Duration: May 2003-April 2004
Microwave links used for communication over water bodies are affected by multi-path that cause their failure. The tracking of objects at low grazing angles at Ka-Band in sea skimming mode is thus severely affected by multi-path induced errors. The goal of this project is to establish a correlation between environmental parameters and the mono-pulse error generation mechanism and to provide plausible solutions after simulation studies to minimize multi-path induced errors.

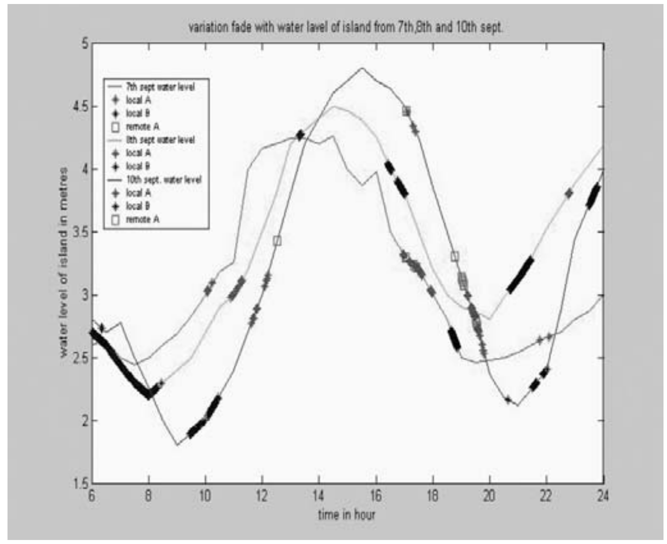

Fig. 3. Correlation between the time of fade and the water level.

Courses

ICRS has conducted a one-week course on Radio-meteorology for the Indian Navy in February 2004. It is also planning to start the P.G. diploma course and to conduct five-day course on antenna theory.

Conferences organized by ICRS

ICRS has been organizing annual conferences in related topics. It has already organized four National Conferences and one International Conference. The details of the Conferences organized by ICRS are as follows:

1. National Conference on "100 yrs of discovery of mm wave," December 1998,
2. National Conference on "Microwave Remote Sensing of Land," January 2000,
3. National Conference on "Applications of Radio Techniques in Remote Sensing," November 2001
4. National Conference on "Microwaves, Antenna, Propagation and Remote Sensing," December 2002
5. 1st International Conference on "Microwaves, Antenna, Propagation and Remote Sensing," December 2003

And it will organize the 2nd International Conference on "Microwaves, Antenna, Propagation and Remote Sensing," from 23rd to 25th November 2004, at Jodhpur.

Paper Publications

ICRS has published seven papers in Indian Journal of Radio and Space Physics, seven papers have been accepted and one more has been submitted. The scientists of the center have presented more than twenty-five papers at National and International Conferences.

Conclusion

The ICRS is planning to work in the field of radio-astronomy, information technology, distance education, and to provide solutions to the problems of the common man by using high technology. The ICRS has committed itself to undertake research activities in radio sciences, initially started by Sir J.C. Bose, to keep his memory alive. ICRS will look for support from national and international organizations. ICRS has signed MoUs with institutions and universities all over India, and plays a meaningful role in the *Nation Building through Human Resource Development*, as well as through the applications of high technology for the upliftment of the common man.

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Students Profile

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Figure 2. National Robotics Contest 2004 edition

1. Introduction

Since its foundation in 1994 as a student association at the School of Telecommunication Engineering (*Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona*, ETSETB), *AESS Estudiants* has been located at the *Campus Nord* of the *Universitat Politècnica de Catalunya* (UPC) in Barcelona, to encourage the student community to understand and get involved in scientific and technical areas such as communications and control systems, navigation and positioning systems, robotics, artificial intelligence, space systems… Now, after ten years *AESS Estudiants*, loyal to its heritage, continues this non-easy task.

2. The members

Due to its close relationship with the ETSETB, the natural source of active members are the students of the School of Telecommunication Engineering. However, one of the main characteristics of our association is that it is open to members and collaborators from other different Schools and Universities. The association has counted within its main active body with students and graduates from Computer Science, Physics, Geology, Electronics Engineering, Aeronautics Engineering… and of course, Telecommunications Engineering. *AESS Estudiants* is indeed formed by enthusiastic people with different backgrounds and motivations with the objective of organizing courses, events, expositions, and all kind of activities, year after year.

Figure 1. AESS Estudiants' robotics branch symbol

Being a member of the *AESS Estudiants* association is voluntary and free of charge, with no other requirement than to obtain a personal satisfaction for the time invested. The association acts as a meeting point to be in contact with other enthusiastic people and to facilitate the participation of its members and collaborators in other external activities.

The members of *AESS Estudiants* share a joint interest in the application of the knowledge gathered during their university studies and the desire to approach the University community to the scientific and technical environments, that sometimes seem to be too far away. To achieve these objectives a large number of activities are organized along the year.

3. The Organization

The legal existence of the association requires a directive board consisting of a President, a Secretary, and a Treasurer in charge of the administrative tasks. *AESS Estudiants* is organized in two different, but interactive sections: the *Astronomy and New Technologies* branch, and the *Robotics* branch, each one under the supervision of a Branch Chief (Astronomy & NT Chief and Robotics Chief). The association webmaster and system administrator is the sixth member of the *AESS Estudiants* directive board.

4. Funding and collaborations

Due to the relationship between the association and the Technical University of Catalonia, the main source of funding of *AESS*

Estudiants is obtained from the allocated budgets of the ETSETB and the UPC to support student activities. There is an important economic collaboration from the Barcelona City Council as well. Another different funding source is the self-financing, basically through the organization of several courses. These funds and others from collaborations with different institutions, agencies and companies allows *AESS Estudiants* to carry out an important number of activities throughout the years.

5. Activities

During the ten years of existence of *AESS Estudiants*, the association has carried out a great assortment of different activities, some of them classics now, organized cyclically every one or two years. The activities organized by each of section include lectures and conference series, exhibits, contests, video and film screenings, visits, astronomical observations, as well as the organization of courses and the collaboration in technical articles.

AESS Estudiants also tries to stimulate among its members the participation in external activities such as robotic contests, planned visits and outreach, and educational activities. This participation enriches not only the members, but the association as well. Among the most popular activities organized every year *AESS Estudiants* has the privilege of being the organizer of very successfully ones:

- **Spanish National Robotics Contest**

Our oldest and probably most popular activity, was first celebrated on March 29th, 1995. At that time it was the first robotic competition ever been in Spain. Every year the competition attracts many students from Spanish universities to compete and to demonstrate the abilities of their self-made robots. There are three competing categories and nine awards:

Sumo Fighters. After 9 editions, the sumo fighters category is undoubtedly the most spectacular one. The contest consists of simulating a sumo fight, where two robots have to find its opponent and throw it out of the circular ring. The imagination showed by the competitors in this kind of contests is amazing, surprising every year with new gadgets and inventions to make the robot a little bit more powerful.

Sniffers. After 7 editions, the sniffer contest is the most popular category and, technologically speaking, the simplest one. In this competition the robots have to follow a white line over a black surface. The participation in this category has always been very large.

Cleaners. After 6 editions, the participants in the cleaners contest have to clean a closed surface by collecting the rice grains spread around, avoiding the distributed obstacles that simulate the house furniture, and it has also to empty its deposits into a prepared recipient. All this requires the use of computer-controlled detection and collection systems.

At present, *AESS Estudiants* is working to introduce new categories to the contest in future editions.

- **Robotics Course**

Oriented to introduce to the basics of robot design and development, the Robotics Course has been given twice per year as a complement to the Robotics Contest with a great success. This year *AESS Estudiants* the first edition of the Advanced Robotics Course has taken place, a revised and updated version of the classical course.

Figure 3. Expo-ESA 2004 logo

- **Expo-ESA**

In 1999, aiming at introducing the possibilities of the space sector in an attractive way to the students as well as to foster it, *AESS Estudiants* started an ambitious project: *Expo-ESA*. The event comprises a series of conferences and exhibits devoted to present the latest progress of the European space sector. The objectives of Expo-ESA are to demystify the space sector and to reduce the gap with the public. *AESS Estudiants* believes it is a necessary to present the advantages of the sector and to participate in an area which is undergoing an important expansion. *AESS Estudiants* is deeply committed to disseminate this issue.

To achieve these objectives, *AESS Estudiants* wants to let know the activities of the *European Space Agency* (*ESA*) in which Spain is an active member, to present the Spanish and

Figure 4. Diego Martinez (fourth from right) and members of the organization of Expo-ESA 2004

Figure 5. Mars rover emulation

Catalan firms collaborating in ESA projects, to present the involvement of UPC in space technologies, and to facilitate the participation of students in space-related activities, as well.

The present edition *Expo-ESA 2004*, held from March 24th to 31st, 2004, included an open exposition including a Martian rovers emulator over a simulated Martian surface and the following lectures and round tables constituted the central body of the activity.

- **Rosetta** (D. Martínez, *ESA*).
- **SMOS/MIRAS** (A. Camps, *UPC*; M. Martín-Neira, *ESA*; J. Casas, *Mier Comunicacions*; J. Font, *Institute of Marine Sciences/CMIMA-CSIC*; and J. Miranda, *UPC*).
- **Zero Gravity** (G. García, *IEEC*).
- **Space Medicine** (G. Sabater, *ESA*).
- **Catalonia in the Space Sector** (J. Isern, *IEEC*; J. M. Lecue, *BAiE*; R. Bennassar, *GTD*; S. Soley, *Pildo Labs*; A. Maiques, *StarLab*; F. Gallart, *NTE*; F. Costas, *Mier Comunicacions*).
- **Mars Express** (A. Chicarro, *ESA*).
- **Barcelona and the presidency of Ariane cities** (L. Gómez, *Barcelona City Hall*).

• **Astronomical Observations**

This is a natural activity of the *AESS Estudiants Astronomy and NT branch* which was boosted with the acquisition of a Newtonian 203 mm telescope in 2001. Astronomical observations of special events have been performed since the early beginning of the creation of the branch. The completion of the system with a new set of oculars and a solar filter in 2003 has increased the quality of the observations. An astrophotography kit will be acquired soon.

• **Observational Astronomy Course**

After years of astronomical observations, *AESS Estudiants* decided to offer the first *Introductory Course of Observational Astronomy* in 1999. At the present time the course is being refurbished to offer the optimal theoretical background and the best observational experiences.

• **Remote Sensing Series**

Another important activity carried out by *AESS Estudiants* under the name *TELEDECT* consists of a lecture series to point out the important role of remote sensing technologies and the significant work carried out by UPC in this field.

TELEDECT '02, the first edition of this series, was envisioned as a single event covered with the following conferences.

- **The SMOS Earth Observation ESA Opportunity** (A. Camps, UPC).
- **LIDAR** (F. Rocadembosch, UPC).
- **Microwave Emissivity models** (N. Duffo, M. Vall-llossera, UPC).
- **Microwave altimetry** (J. J. Martínez-Benjamín, UPC).
- **Interferometric RADAR applied to Remote Sensing** (A. Broquetas, UPC).
- **Determination of the wind speed and direction over the sea surface using GPS opportunity signals** (E. Cardellach, IEEC).
- **Altimetry at ESA's mission ENVISAT** (M. Roca, ESA).

After the great success and the high interest of this lecture series, the *TELEDECT '04* a edition was organized, between March and May 2004. The main lectures are listed below, focused this time on applied sciences and Master opportunities offered in Barcelona.

- **LIDAR** (F, Rocadenbosch, UPC).
- **Interferometry** (A. Broquetas, UPC).
- **Remote Sensing at IEEC** (P. Elósegui, IEEC).
- **IEEC's Remote Sensing Master** (J. Cristóbal, IEEC).
- **Passive Remote Sensing from Space** (J. Miranda, UPC).
- **Remote Sensing Applications in Cartography** (Institut Oceanogràfic).
- **Polarimetric Interferometry** (X. Fàbregas, UPC).

6. Conclusions

*AESS Estudiants*is a student association created ten years ago at UPC. After this first decade, it still keeps seeking new challenges and opportunities, accumulating expertise and fascinating the public with the activities organized, and most important carrying out them in close collaboration with students, graduates and professionals. New projects will arise, and *AESS Estudiants* will not have fear to carry them out.

7. References

For further information, please refer to the following web pages.

http://aess.upc.es
http://aess.upc.es/expo-esa
http://aess.upc.es/concursrobot
http://www.etsetb.upc.es
http://www.estec.esa.nl/outreach
http://www.tsc.upc.es/eef/research_lines/mrs/pasiu/remote_sensing.htm

Report on the 8th Specialist Meeting on Microwave Radiometry and Remote Sensing Applications

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The 8th Specialist Meeting on Microwave Radiometry and Remote Sensing Applications (MicroRad04) was held on **February 24-27, 2004 in Rome, Italy**. The Meeting was an overwhelming success, much over any expectation. This exciting success can be summarized by few numbers such as 162 submitted abstracts, 152 participants, 85 oral presentations and 42 interactive posters along 4 full days of session works.

The MicroRad04 was held at the **Engineering College**, situated in one of the most beautiful sites of the Eternal City, between the Colosseum, the archaeological area and the early Christian Basilicas. It is worth mentioning the courtyard of the College (see picture), enriched by a piece of art dating back to Renaissance architecture: the ancient well designed by S. Mosca. The Engineering College occupied the area of an ancient Monastery, *S. Pietro in Vincoli* (St. Peter in Chains), situated on the gentle slopes of the Esquilino hill (one of the seven hills on which Rome was built). The Church of **S. Pietro in Vincoli** was built on the Empress Eudossia's buildings, to preserve St. Peter's chains. These can be found still nowadays in the Church, together with the large statue of Moses, sculpted by Michelangelo as part of the tomb of Pope Julius II.

The MicroRad04 Meeting is the **latest of a series** focusing on Microwave Radiometry and Remote Sensing of the Environment. The very first one dates back to **March 1983**, when it was organized and supported by the University "La Sapienza" of Rome, Italy, as a result of the initiative of Prof. G. d'Auria. The satisfactory outcome of the first Meeting stimulated an agreement among the participants to ensure the continuity in the form of a periodical meeting opportunity, the second of which supported by IROE-CNR in Florence, Italy, occurred in 1988. Since then, more regular meetings, every 30 months approximately, have been scheduled and held in the US and in Italy, alternately. In 2001 the Meeting was hosted by NOAA in Boulder, Colorado.

The MicroRad04 Meeting was organized by the **Department of Electronic Engineering** of the University "La Sapienza" of Rome and was thought as an open invitation to convene again in Rome, after twenty years from the previous opportunity. The objective of MicroRad04 was to set up a common forum to report and discuss recent advances in the specific field of microwave radiometry, thus gathering all parties belonging to the research and industrial community, active in projects and studies in microwave radiometry of atmosphere, ocean and land.

Contributions on topics of primary interest have been received. When building up the program, the usually poor consensus towards parallel sessions has been taken into account. The repartition of papers into both **oral and interactive sessions** is therefore intended as a straightforward to accommodate each author's wish to contribute to the Meeting with his/her own work. The denomination "interactive", that identifies poster presentations, reflects the concept of an open dialogue between the Authors and the Audience, for mutual benefit and for a cross-check of experiences and results.

A picture of MicroRad04 participants in the old cloister of the Engineering College.

The **15 sessions of the Meeting** were focused on classical and new advanced topics of environmental remote sensing by microwave radiometry, emphasizing the methodological, instrumental, and application point of views. Interdisciplinary and sensor synergy issues were also stimulated. The Meeting was opened by the greetings of the Faculty Dean Dr. T. Bucciarelli and of the Director of Electronic Engineering Dept. Dr. G. d'Inzeo as well as by an introduction of the Scientific Chairman Dr. G. d'Auria. Two sessions, chaired by Dr. A. Camps, Dr. S. Reising, Dr. A. Shibata and Dr. N. Skou, were devoted to sea salinity, sea wind and ice. Following two sessions, chaired by Dr. F.S. Marzano, Dr. Y. Kerr, Dr. M. Martin-Neira and Dr. E. Njouku, dealt with missions and experimental campaigns. At the end of the first day delegates of ESA, AIPAS and Alenia Spazio gave a presentation on their activities during a session chaired by Dr. N. Pierdicca and F.S. Marzano. A session, chaired by Dr. A. Shutko and Dr. S. Paloscia, was devoted to soil and vegetation, while Dr. T. Hewison, Dr. C. Prigent, Dr. S. Crewell and Dr. N. Grody chaired two sessions on clear-air and clouds applications. The second day was concluded by a session on snow cover, chaired by Dr. M. Hallikainen and Dr. P. Pampaloni. A session on electromagnetic models, chaired by Dr. D. Solimini and Dr. A. Voronovich, and a session on retrieval methodologies, chaired by Dr. R. Ware and Dr. E.R. Westwater, opened the third day. Two sessions, chaired by Dr. R. Ferraro, Dr. J. Turk, Dr. V. Chandrasekar and Dr. A. Mugnai, were dedicated to clouds and precipitation remote sensing. The last day of the Meeting was devoted to both sensor calibration and instrument and advanced techniques with chairpersons Dr. A. Gasiewski, Dr. G. Schiavon, Dr. P. Racette, Dr. H. Suess, Dr. I. Corbella and Dr. D. Le Vine.

Indeed, during the Meeting, **special environmental "effects"** were also foreseen, as pointed out by Dr. G. Calabresi, the scientific secretariat of the Meeting. As a matter of fact, the week was affected by a rigid weather with temperatures well below the seasonal average in Rome, northern winds and some showers. Nonetheless, the participants enjoyed both the Meeting and the city.

Dr. G. d'Auria and Dr. D. Solimini with their wives during the social dinner.

Last, but not least, the number of participants who attended the **social dinner** were 88, more than 55% of the Meeting attendees (see picture). The dinner was held in a typical Roman restaurant, called "Orazio", close to the *Terme di Caracalla* and *Fori Romani*. The meal was delighted by good local food and wine. At the end of the dinner a bus was offered for a memorable night sightseeing of Rome (in spite of the drizzle).

Dr. N. Pierdicca, Dr. F.S. Marzano and Dr. G. d'Auria during the MicroRad04 cake party on the last day.

The Meeting was concluded by a **MicroRad04 cake party** (see picture) and by the announcement of the **next Specialist Meeting** which will be held in Amherst at the University of Massuchessetts, MA, USA, chaired by Dr. S. Reising and planned on October 2005.

The **workshop proceedings** will be published on a CD-ROM which will be distributed to all participants and to those who will ask for. Full papers are solicited for a **MicroRad04 special issue** of the IEEE Transactions on Geoscience and Remote Sensing, whose deadline is on May 1st, 2004. See either the GRSS web site for details of the special issue or the MicroRad04 web site at http://www.microrad04.org.

Many people and institutions made the MicroRad04 conference an amazing success. The Meeting co-chairs, Dr. N. Pierdicca and Dr. F.S. Marzano, would like to acknowledge the outstanding work of the **local organizing team**, led by Dr. G. Calabresi and Dr. L. Pulvirenti with the help of Mrs. S. Pongracz, Mr. M. Mazzetta and M. Fascetti. A thankful acknowledgement goes to the session chairpersons and to the **Scientific and Steering Committee**, composed by Dr. G. d'Auria, Dr. A. Gasiewski, Dr. B. Greco, Dr. R. Guzzi, Dr. M. Hallikainen, Dr. M. Martin-Neira, Dr. A. Mugnai, Dr. S. Paloscia, Dr. P. Pampaloni, Dr. D. Solimini, Dr. C.T. Swift, Dr. J. Vivekanandan, and Dr. E.R. Westwater. A final acknowledgment is addressed to the MicroRad04 **sponsorship** from IEEE-GRS-S, URSI, and University "La Sapienza" of Rome Alenia Spazio, CETEMPS – University of L'Aquila, ESA, AIPAS, AMS-Gematronik, ASITA, AIT, IEEE-GRS Central-South Italy Section, CETEM and ASI.

See you in Amherst, then, for next MicroRad!

Data Archiving and Distribution Technical Committee

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Background

The storage, use, distribution, archiving, visualization, and analysis of geospatial imagery and collateral data presents technological challenges that must be overcome if these data are to be effectively used in research and in real-time decision making processes. There is an increasing need for the development of real-time technology to use on-line imagery and collateral geospatial data, both raster and vector sources. These data are needed for an increased understanding of Earth system processes (e.g., climate, weather, and oceans), advanced geospatial mapping, and enhanced analysis applications. Significant research is being conducted in the distinct areas of digital libraries, distributed computational technologies, cyberinfrastructure, scalable storage architecture, data archiving, data visualization, and spatial data analysis. The Data Standardization and Distribution (DSD) Technical Committee (TC) of GRS-S was formulated in 1994 to address some of these issues. Table 1 lists the names of the individuals who have provided leadership to this TC over the last 10 years.

Mission and Scope

As originally conceived the DSD mission and scope was:

"To study the standardization and application of remotely sensed data with particular emphasis on storage, distribution, visualization, and analysis."

With this charge, much of the TC's early efforts were spent on data standardization issues. However, since data standards are intimately connected to the associated application software (within which data is ultimately used), as well as the telecommunication channels and media used for its transmission and storage, it was decided by the IEEE GRS-S AdCom in 2001 that the charge of the DSD TC be modified to better reflect the rapid evolution in data transmission, storage, and access. Accordingly, the name was changed to the Data Archiving and Distribution (DAD) TC, with the following charge:

"To provide recommendations and responses to issues related to the archival and distribution of remotely sensed geospatial and geotemporal data, and on how new media, transmission means, and networks will impact the archival, distribution, and format of remotely sensed data. Also, to study the impact of media, channel, and network scaling on the archival and distribution of data."

Therefore, the scope of the present DAD TC has expanded from just addressing a myriad of data standardization issues to now include the enabling technologies for delivery of data and information to the science and application communities served by GRS-S. These data have been expanded to include both raster and vector products. Now, areas for consideration by the committee include: distributed resources, computational grids, computational portals, search, scalable storage architectures, media, data mining, data compression, toolkits, and visualization.

Committee Activities

In general, the DAD TC promotes the study of the manipulation and rendering of large data sets for geoscientific purposes. Since many important Earth system science problems require the ability to explore and integrate data obtained from a wide variety of sources, this area of research is becoming of more interest to the TC. Rather than creating a single information system to meet the evolving needs of a wide variety of users, it is now possible to create, through a cyberinfrastructure, a federation of distributed databases with universal standards for archiving and to provide common and easily used visualization tools. However, because remotely sensed data streams or data sets will continue to push the available transmission bandwidth and storage technology to extreme limits, there will need to be a long-term research focus on developing special techniques for the handling, distribution, application, rendering, fusing, mining, and compression of remotely sensed imagery and collateral data. For example, methodologies to mine federated storage systems to enable semantic querying and seamless merging of data from different instruments and missions in order to answer complex, large-scale scientific questions.

The DAD TC is developing a prioritized agenda for research in data archiving and distribution via inputs from its membership. The IEEE GRS-S membership is encouraged to participate in this process. The existing research agenda is on the TC's website.

A special responsibility of the DAD TC is to function as a liaison between the IEEE GRS-S and the International Standards Organization (ISO) on standards for geographic information (ISO TC211). This liaison was organized with the assistance of George Percivall of the NASA Goddard Space Flight Center in 2000. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. The work links to appropriate standards for information technology and data where possible, and provides a framework for the development of sector-specific applications using

geographic data. The DAD TC now serves as a clearinghouse for coordinating any GRS-S members' comments on ISO TC211 proposed standards. Recently, Siri Jodha Singh Khalsa has volunteered to represent GRS-S more actively on two different TC211 projects:
19101-2, Geographic Information - Reference Model - Imagery
19115-2, Metadata for imagery.
At IGARSS '04 the DAD TC will sponsor a special technical session on *Image Information Mining (I2M) and Intelligent Data Understanding (IDU)*. The DAD TC sponsored a special session on *Data Services and Tools* at IGARSS '02 and one on *Best Practices for Geospatial Data Management* at IGARRSS '03. The DAD TC web site has links to the presentations associated with these special sessions and links to related sites of interest. Anyone wishing to join the Data Archiving and Distribution Technical Committee is encouraged to contact one of the co-authors of this article.

Year	Data Archiving and Distribution[1]
1994	John Curlander
1994-95	Tony Freeman
1995-96	William J. Emory
1996-97	Daniel Ziskin
1997-98	Daniel Ziskin
1998-99	Daniel Ziskin
1999-2000	Larry E. Fishtahler
	Richard E. Ullman
2000-01	Larry E. Fishtahler
	Richard E. Ullman
2001-02	Roger L. King
2002-03	Roger L. King
	Liping Di
2003-04	Roger L. King
	Liping Di

Call for Papers TGARS Special Issue on Global Land Product Validation

There are increasingly more global land products being made available through the Committee on Earth Observing Satellites (CEOS) members. As more, and similar, products are made available, several critical questions arise. How readily accessible are the data? Which product is best? Are combinations of products possible and beneficial? What is required to combine results between sensors and satellite platforms to construct a consistent long-term climate data record? An essential first step in addressing these questions is to lay out the current suite of global land products and quantitatively establish their accuracy.

This call is **open to all authors** and solicits papers pertaining to accuracy assessment, or validation, of **global land products**. The issue will be divided into three general areas: radiation budget, ecosystem, and land cover variables. Papers assessing multiple products, multi-sensor analysis, as well as global land product users' accuracy requirements are encouraged.

Procedure:
Prospective authors should follow the regular guidelines of the IEEE Transactions on Geoscience and Remote Sensing as listed inside the back cover of the Transactions issue. Funds will be available to share some cost of color prints. Authors should submit their manuscripts electronically to http://grs-ieee.manuscriptcentral.com. Instructions for creating new user accounts, if necessary, are available on the login screen. Please indicate in your submission that the paper is intended for the Special Issue on Global Land Product Validation by selecting "LPV Special Issue" from the pull down menu for manuscript type. Questions concerning the submission process should be addressed to tgrs-editor@ieee.org.

Inquiries concerning the Special Issue should be directed to the Guest Editors:
Jeff Morisette, NASA's Goddard Space Flight CenterEmail: jeff.morisette@nasa.gov
Fredrick Baret, INRA-CSE Agroparc, FranceEmail: baret@avignon.inra.fr
Shunlin Liang, University of Maryland, USAEmail: sliang@geog.umd.edu

Submission Deadline: October 1, 2004

IEEE Workshop on Remote Sensing of Atmospheric Aerosol

An Honorary Workshop for Prof. John A. Reagan

January 12-13, 2005

Workshop Chairs: *Thomas Cooley, Air Force Research Laboratory, General Chair*
Thomas.Cooley@kirtland.af.mil (505-846-2986)
Ali H. Omar, NASA Langley Research Center, General Co-Chair
ali.h.omar@nasa.gov, (757) 864-5128

Technical Committee: David Winker (NASA Langley Research Center), Ed Browell (NASA Langley Research Center), Jacques Pelon (University of Paris, France), Kurt Thome (University of Arizona), Jim Spinhirne (NASA Goddard), Brent Holben (NASA Goddard), Mike Hardesty (NOAA), Phil Russell (NASA Ames).
Location: University of Arizona Student Union, Tucson Arizona, USA

Prof. John Reagan of The University of Arizona, an internationally known leader in the field of atmospheric aerosol sensing, will be stepping down from his position as a Professor of Electrical and Computer Engineering after more than 35 years of fundamental research and educating scientists and engineers to become leaders in all levels of academia, industry and government. For more than three decades Professor Reagan applied his background in electrical engineering to the science of atmospheric aerosol characterization, and along with his colleagues and students, developed several pioneering techniques in remote sensing. Some of these methods have improved our understanding and quantification of such important phenomena as the effects of clouds and aerosols on radiative transfer and the consequences of aerosol forcing on climate. Spectral measurements of aerosol optical depths from the surface have become a mainstay for the remote sensing community as a result of the "Reagan Sun Photometer" developed and manufactured by students under his guidance. Professor Reagan is very active in the LIDAR research community and his experience and contributions range from field measurements in the Arizona desert to pioneering shuttle-based lasers (LITE) and the upcoming satellite-based CALIPSO LIDAR. In addition to field measurements, Professor Reagan has been instrumental in the development of some key LIDAR data inversion techniques (Fernald), calibration methods (LITE and CALIPSO algorithms) and extinction to backscatter (Sa) estimation. From ground-based LIDARs in the 1970s to spaceborne systems aboard the space shuttle and satellite-based systems, Professor Reagan's career has had a profound impact on the development and use of laser energy to probe the atmosphere. The science community is fortunate that Prof Reagan will assume Professor Emeritus status at the University of Arizona and will remain active in several communities.

The aim of the workshop on **Remote Sensing of Atmospheric Aerosols** is to celebrate the work of Professor John A. Reagan, to create an open forum for critical evaluation of the evolution of methodological approaches over the past decades, and to discuss fruitful directions for future work through lively interaction. The venue for the two-day workshop will be the University of Arizona new Student Union Complex. Three distinguished speakers will be invited to address both the progress of remote sensing data analysis during the last few decades and provide perspective on the most critical needs for future methodological advances. Major emphasis will be given to open discussions at the workshop. A CD with the proceedings will be produced following the workshop.

Session topics will include the major research areas of his career: a) Passive Remote Sensing Characterization of Aerosols, b) Active LIDAR Remote Sensing of Aerosols, c) Retrieval Algorithms of Aerosol Properties, and d) Data and Information Fusion of Aerosol Measurements.

Specialists Workshop

on EM Scattering Modeling and Information Retrieval in Remote Sensing

***Fudan University, Shanghai, China* August 25-27, 2004**

The Specialists Workshop on EM Scattering Modeling and Information Retrieval in Remote Sensing will be held in Fudan University, Shanghai China in August 25-27, 2004.

This workshop provides an academic forum to exchange recent research progress and discuss future topics in EM scattering and remote sensing information (theoretical model and simulation, data validation and information retrieval, and applications).

This workshop is sponsored by IEEE Geoscience and Remote Sensing Society, China State Major Basic Research Project via 2001CB309400, the Natural Science Foundation of China, IEEE Beijing Section and IEEE GRSS Beijing Chapter.

IEEE GRSS

NSFC

CIE

Fudan U

The following topics are suggested:

1 *Wave scattering, propagation and emission in natural media*
2 *Models for active and passive remote sensing*
3 *Data validation and parameter retrievals for remote sensing of land, ocean and atmosphere*
4 *Rough surface scattering, low grazing scattering*
5 *Data fusion, data assimilation, data mining, and scattered data approximation*
6 *Target detection and imaging in clutter, subsurface sensing*
7 *Inverse scattering*
8 *SAR and INSAR*
9 *Image and signal processing in remote sensing*

All attendees are required to send a A4 page abstract in English for 30 minutes presentation on above topics.

Deadline for the abstract submission is August 10.

Further contact and the abstract should be emailed to:

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Professor Ya-Qiu Jin,
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Shanghai 200433.
Tel./Fax: 0086-21-65643902

No registration fee is required

Abstract submission: ***before August 10***
Registration Day: ***August 25***
Workshop Days: ***August 26-27***

RADAR POLARIMETRY AND INTERFEROMETRY: A TUTORIAL INTRODUCTION

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Introduction

Over the next few years several new free-flying remote sensing satellites will be deployed in orbit, providing the international scientific, commercial and political communities with a wealth of new data. Many of these will carry advanced multi-channel imaging radars designed to combine various levels of polarisation diversity with radar interferometry. In this article we motivate interest in such sensors by providing a tutorial introduction. In particular, we focus on the importance of multi-channel phase for active remote sensing applications and use it to demonstrate how imaging polarimetric interferometry or POLInSAR leads to exciting new possibilities for the use of radar in quantitative mapping of vegetated surfaces.

The Propagation and Scattering of Polarised Waves

In radar polarimetry [1] we seek control over the shape of the transmit (and receive) polarisation ellipse, as shown schematically in figure 1, for the purposes of improved information extraction. Figure 1 shows the spatial helix resulting from a combination of horizontal (H, in green) and vertical (V, in blue) transmitted components. By controlling the relative amplitudes we can rotate the polarisation from H through 45 degrees to V. However, by adjusting the relative timing (phase) of the blue and green components we can also adjust the shape of the ellipse. It is this combined amplitude and phase dimension that leads to increased information content in remote sensing applications, since the level of scattering we observe from natural terrain depends on the shape of this ellipse. [1–5]

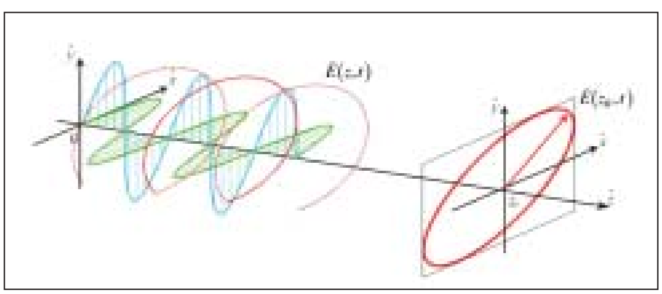

Figure 1: The Polarisation Ellipse and Spatial helix decomposed into orthogonal components x (horizontal H) and y (vertical V)

To represent this combined amplitude and phase control mathematically, we describe the wave using a pair of complex numbers, e_x and e_y as shown in equation 1. The phase difference i.e. $\phi = \arg(e_x e_y^*)$ then controls the shape of the ellipse, with linear polarisations defined by $\phi = 0$. Note that the ellipse is actually a dynamic quantity, being the time locus of the helix in a fixed spatial plane. Consequently the locus can move clockwise or counter-clockwise (when viewed in the $-z$ direction), corresponding to what are termed left and right-handed polarisations respectively. The set of all possible left and right handed ellipses can then be conveniently mapped onto the northern and southern hemispheres of the Poincaré sphere. [1, 6]

Furthermore, our ability to extract quantitative information rests on the stability of this phase or the robustness of the spatial helix to small time and spatial shifts. A generic way to define the stability of this helix is to use the wave coherency matrix $[J]$, taken at a point in space with position vector $\underline{r}$ and formed as an average of all possible complex products between e_x and e_y as shown in equation 1, [6]

$$e_x\hat{x} + e_y\hat{y} \Rightarrow \underline{E} = \begin{bmatrix} e_x \\ e_y \end{bmatrix} \Rightarrow [J] = \langle \underline{E} \cdot \underline{E}^{*T} \rangle = \begin{bmatrix} \langle e_x(\underline{r})e_x^*(\underline{r}) \rangle & \langle e_x(\underline{r})e_y^*(\underline{r}) \rangle \\ \langle e_y(\underline{r})e_x^*(\underline{r}) \rangle & \langle e_y(\underline{r})e_y^*(\underline{r}) \rangle \end{bmatrix} \quad (1)$$

As its name suggests, this matrix allows us to calculate not only the wave intensity (from the diagonal components) but also the coherence, which is a measure of the phase stability of the wave, as defined in equation 2 [7]

$$\tilde{\gamma}_{xy} = \frac{\langle e_x(\underline{r})e_y^*(\underline{r}) \rangle}{\sqrt{\langle e_x(\underline{r})e_x^*(\underline{r}) \rangle \cdot \langle e_y(\underline{r})e_y^*(\underline{r}) \rangle}}, \quad 0 \le |\tilde{\gamma}_{xy}| \le 1 \quad (2)$$

A key benefit of employing ratios such as equation 2 is that absolute amplitude terms cancel, so removing some of the

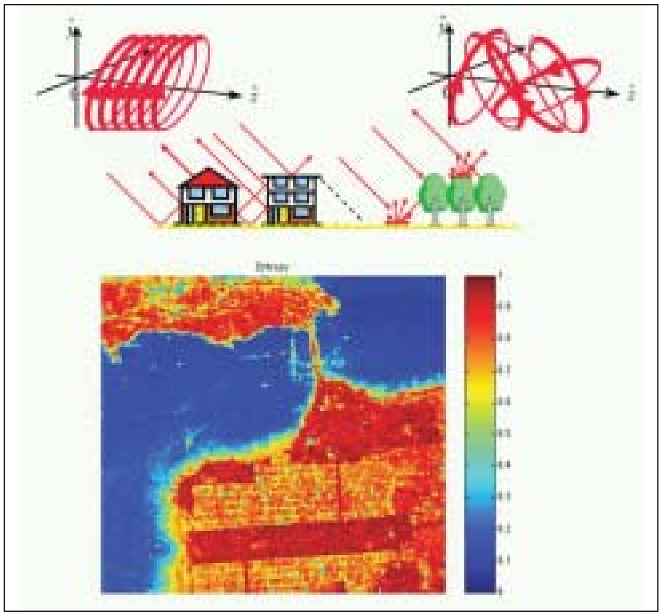

Figure 2: Depolarisation and Entropy: L-Band San Francisco NASA-JPL AIRSAR Data

structural dependence in scattering from random media. It is this observation that shifts interest in polarimetry towards the study of ratios as potentially more robust indicators of physical structure (see examples in table I).

In active microwave sensing we can ensure that $|\gamma| = 1$ for the transmitted wave and hence the transmitted spatial helix is very stable. However, when the wave is scattered or reflected from natural media, its phase and amplitude will in general be modified (as shown schematically in figure 2). This process again must be described by a set of complex numbers, this time by a set of four, being the elements of the coherent scattering matrix $[S]$ defined as shown in equation 3. This matrix characterises all possible phase and amplitude changes due to co-polar (diagonal elements) and cross-polar (off diagonal) scattering. In practice, for the common case of backscatter, the reciprocity theorem for electromagnetic waves reduces this set to three complex numbers, as the cross-polarisation terms are equal $S_{HV} = S_{VH}$. Note that while this is widely true, there are a few special but important cases where it breaks down, as for example in low frequency radio wave propagation through the ionosphere, where the Earth's magnetic field lines break this reciprocity symmetry and as a result the cross polarisation terms are no longer equal. This observation can be used to calibrate the effects of Faraday rotation due to trans-ionospheric propagation, an important issue for the deployment of low frequency space-borne radars. [8]

$$\underline{E}_s = \frac{e^{ikr}}{r}[S]\cdot\underline{E} \Rightarrow [S] = \begin{bmatrix} S_{HH} & S_{HV} \\ S_{VH} & S_{VV} \end{bmatrix} \xrightarrow[S_{HV}=S_{VH}]{\text{reciprocity}}$$

$$\underline{k} = \begin{bmatrix} S_{HH} \\ \sqrt{2}S_{HV} \\ S_{VV} \end{bmatrix} \Rightarrow [C] = \langle \underline{k}\cdot\underline{k}^{*T} \rangle \quad (3)$$

Table I: Examples of Geophysical Parameter Estimation using Radar Polarimetry and Interferometry

Product	Radar Parameter	Polarimetric and Interferometric Measurement Parameters	Source Reference
Bare Surface Roughness	$0 \le f(ks) \le 1$ s = rms roughness k = wave number = 2π/λ	[illegible]	10,11,15
Bare Surface Moisture	$0 \le M(\theta, \varepsilon_r) \le 1$ θ = angle of incidence ε_r = dielectric constant	[illegible]	10,11,15
Surface Slope	[illegible] tan γ = range slope tan ω = azimuth slope θ = radar look angle	[illegible]	12,14
True Ground Topography	[illegible]	[illegible]	[illegible]
Vegetation Component Structure	[illegible]	[illegible]	4,16,17
Vegetation Height and Extinction	h_v = top height σ = mean extinction θ = angle of incidence φ = ground topographic phase (see above)	[illegible]	20,21,22

One key idea in polarimetry is that if we know all four of these $[S]$ matrix elements then we can calculate the phase stability of the scattered signal for arbitrary incident ellipse, using a 3×3 covariance matrix $[C]$ as shown in equation 3. In this way we don't have to actually change the shape of the transmit ellipse (which would call for control of the antenna and microwave electronics) but can simulate the same effect off-line in the processing stages. For this reason there has been a lot of interest in the development of microwave switching systems that are capable of measuring all four elements of $[S]$ (the simplest is to switch each transmit pulse between X and Y orthogonal polarisations with simultaneous reception of the X and Y components). Note that one important step is to calibrate system distortion effects due to crosstalk (which causes problems with estimation of the off-diagonal elements of $[S]$) and channel imbalance due to phase and amplitude distortions of the radar system itself. The development of robust calibration procedures has been a key enabling step in the quantitative exploitation of this technology [9]. Such systems are called 'quadpol' as they measure 4 complex numbers for each pixel in the image and allow the user to explore the whole Poincaré sphere. There are currently several mature airborne quadpol radar sensors with such a capability, but significantly there will soon be a new generation of free-flying satellite radars operating in this mode. The European Terrasar-X/L, Japanese ALOS-PALSAR and Canadian Radarsat-2 are important examples. The main question then becomes, how can we find the best polarisation combination to derive information products exploiting the scattering of waves from surfaces and vegetation? To answer this we must look more carefully at equation 2 and the whole issue of coherence.

Coherence and Entropy

To calculate polarimetric coherence, first choose a pair of polarisations x and y, then measure the (complex) components of the signal in these two channels and estimate the coherence by averaging. However, even for a fixed wave, the coherence obtained with this method will depend on the choice of our reference pair x and y (e.g. choosing $x = y$ will give a coherence of 1, while less obvious but more important is the idea that for every wave we can choose an orthogonal pair x and y so that the coherence is zero). This goes against the idea that the spatial helix is somehow independent of the co-ordinates we use to represent it, and that consequently we should be able to describe its stability in co-ordinate invariant terms. One way to do this is to describe the helix stability using a generalised coherence or entropy (another popular way is to use the degree of polarisation [6]). The wave entropy is formally defined from the ratio of eigenvalues of $[J]$ (see equation 4) and has a value of 0 when the helix is perfectly stable and 1 when it becomes noise like [2, 4, 6].

$$0 \le H_w = -\sum_{i=1}^{2} p_i \log_2 p_i \le 1, \quad p_i = \frac{\lambda_i([J])}{\sum \lambda} \tag{4}$$

By extension, we can also describe the loss of helix stability *after* scattering by the entropy of the 3×3 covariance matrix $[C]$ in equation 3, as defined in equation 5 [2, 4]

$$0 \le H_s = -\sum_{i=1}^{3} p_i \log_3 p_i \le 1, \quad p_i = \frac{\lambda_i([C])}{\sum \lambda} \tag{5}$$

It is important to realise that this scattering entropy is characteristic of the scattering medium itself. For example, for low frequency volume scattering from a cloud of ellipsoidal particles of dielectric constant ε_r and axial ratio m, the normalised eigenvalues of $[C]$ can be evaluated explicitly as shown in equation 6 [2, 4, 16, 17]

$$m = \begin{cases} >1 \text{ prolate particles} \\ 1 \text{ spherical particles} \\ <1 \text{ oblate particles} \end{cases} \Rightarrow$$

$$R = \frac{m\varepsilon_r + 2}{m + \varepsilon_r + 1} \Rightarrow \begin{cases} \lambda_1 = 2R^2 + 6R + 7 \\ \lambda_2 = (R-1)^2 \\ \lambda_3 = (R-1)^2 \end{cases} \tag{6}$$

For spherical particles ($R = 1$) this leads to zero entropy but for a cloud of 'wet dipoles' (m and ε_r large) the entropy rises to 0.95. Hence a measurement of entropy relates to information about composition of the volume. Importantly, we can estimate scattering entropy numerically on a pixel-by-pixel basis from quadpol radar imaging data. Figure 2 shows an example of the entropy or phase stability of a mixed scene, being the San Francisco Bay area as collected by the NASA-JPL L-Band AIRSAR system. We note that over non-vegetated surfaces the entropy is low and hence the scattered wave helix is very stable for all types of transmit polarisation. This can be exploited for quantitative moisture and roughness estimation of non-vegetated land surfaces by choosing appropriate robust ratios of scattering elements as shown for example in table I. [10–15]

The urban areas in figure 2 show moderate entropy, but the worst case arises for vegetation. Here we see high entropy due to volume scattering by the random components of the vegetation cover (as in equation 6). These observations are independent of the actual scene considered and hence have been suggested by several authors as suitable for robust unsupervised classification of land cover [3–5, 13]. The entropy method has recently been implemented, along with several other approaches, in a software package development sponsored by the European Space Agency and available for download at http://polsarpro.ietr.org.

While useful for classification and limited composition studies, such high entropy for vegetation cover restricts our ability to fully exploit polarisation for quantitative parameter estimation. Yet vegetation cover is of prime importance in remote sensing applications. Somehow, in order to proceed, we have to find a way to reduce the entropy. Importantly this can be achieved by combining polarimetry with interferometry, to form the new topic of imaging polarimetric interferometry or POLInSAR as we now show.

Controlling Entropy: Volume Decorrelation in Radar Interferometry

Radar interferometry employs spatial separation by a baseline vector b of multiple sensors (for single-pass) or a single sensor at multiple times (for repeat-pass) [18]. It then uses phase difference as a proxy for elevation, enabling determination of scatterer height, hence leading to products such as high resolution digital elevation model (DEM) generation. Again however the accuracy of this process is governed by phase stability or coherence. In this case we can define a coherency matrix as shown in equation 7

$$[J]_x = \begin{bmatrix} \langle p_x(\underline{r}) p_x^*(\underline{r}) \rangle & \langle p_x(\underline{r}) p_x^*(\underline{r}+\underline{b}) \rangle \\ \langle p_x(\underline{r}) p_x^*(\underline{r}+\underline{b}) \rangle & \langle p_x(\underline{r}+\underline{b}) p_x^*(\underline{r}+\underline{b}) \rangle \end{bmatrix} \tag{7}$$

where ‘x’ corresponds to a single selected polarisation channel. The presence of vegetation is now modelled as a finite bounded vertical random distribution of scatterers with a spatial weighting to account for the fact that scatterers deeper in the volume will have a smaller influence due to wave extinction σ. With this model, the coherence of vegetation can be expressed as shown in equation 8 [19, 22]

$$
\begin{aligned}
\tilde{\gamma}_v e^{i\phi(z_0)} &= \frac{\langle p_x(\underline{r}) p_x^*(\underline{r}+\underline{b})\rangle}{\sqrt{\langle p_x(\underline{r}) p_x^*(\underline{r})\rangle . \langle p_x(\underline{r}+\underline{b}) p_x^*(\underline{r}+\underline{b})\rangle}} \\
&= e^{i\phi(z_0)} \frac{2\sigma_1 e^{i\phi(z_0)}}{\cos\theta_0 (e^{2\sigma_1 h_v/\cos\theta_0} - 1)} \int_0^{h_v} e^{ik_z z'} e^{\frac{2\sigma_1 z'}{\cos\theta_0}} dz' \\
&= e^{i\phi(z_0)} \frac{p_1}{p_2} \frac{e^{p_2 h_v} - 1}{e^{p_1 h_v} - 1} \\
p_1 &= \frac{2\sigma}{\cos\theta} \quad p_2 = p_1 + ik_z, \\
k_z &= \frac{4\pi\,\Delta\theta}{\lambda \sin\theta} \approx \frac{4\pi B_n}{\lambda R \sin\theta} \qquad (8)
\end{aligned}
$$

where B_n is the normal component of the baseline to the line of sight. There are two key features of this model:

- Coherence (and therefore entropy) can now be controlled by selecting the baseline B_n.
- The interferometric coherence is independent of ‘x’ i.e. of polarisation

The first means that, unlike in polarimetry, we can now design the sensor to control the observed entropy of vegetation scattering (contrast equations 6 and 8). However, the second seems to indicate that we do not need polarisation diversity, as equation 8 does not change with ‘x’. Why then do we need to consider POLInSAR?

The answer to this apparent contradiction is hidden in equation 8 itself. We see that the coherence is a function of several parameters, the unknown height of the vegetation h_v, the unknown wave extinction σ and the unknown ground topographic phase $\phi(z_0)$. It follows that one channel of interferometry by itself cannot be used for unambiguous parameter retrieval. The situation is further complicated by the fact that for microwaves σ can be relatively small and hence there can be penetration of vegetation right down to the underlying surface. This requires us to consider combined surface and volume scattering, so forcing us to modify equation 8 to at least a two-layer model as shown in equation 9 [19–22]

$$\tilde{\gamma}_x = e^{i\phi(z_0)} \frac{\tilde{\gamma}_v + \mu_x}{1 + \mu_x} \qquad (9)$$

where μ_x is the ratio of surface-to-volume scattering, which changes with frequency, vegetation density and surface conditions. However, it is now that polarisation diversity helps, as from figure 2 we see that surface scattering has low entropy and hence we can control its influence in 9 by changing ‘x’ at the same time as leaving the volume coherence unchanged. Consequently by using POLInSAR we can increase the number of observations faster than the number of unknowns and hence achieve parameter estimation with a coherence or entropy under our control. This is one reason why there is such an interest in developing POLInSAR sensors for vegetation mapping [22–24]. Several further examples can be found as part of the proceedings of a recent ESA funded workshop focussing on this topic (http://earth.esa.int/polinsar/).

Figure 3 shows an example POLInSAR product, obtained using the L-band airborne E-SAR sensor operated by DLR in Germany. Here we show a radar-derived quantitative tree height estimation overlaid on a radar-derived DEM. It uses the model of equation 9 with polarisation diversity over ‘x’ to isolate the height h_v and $\phi(z_0)$ dependence and provide a map of tree height over the mountainous terrain. Quantitative comparisons with in-situ measurements indicate an accuracy of height estimation around 10%. [21–24]

While tree height is itself a useful product, it can also provide the basis for various important secondary products. For example, in figure 4 we show a forest biomass map derived using the height data in figure 3 coupled to allometric equations derived from forestry tables for this region [24]. In the upper figure we also show a conventional SAR image of the scene, which displays none of the important forest structural information seen in the height/biomass products. This nicely illustrates the potential ‘information gain’ obtained by using POLInSAR sensors for vegetation applications.

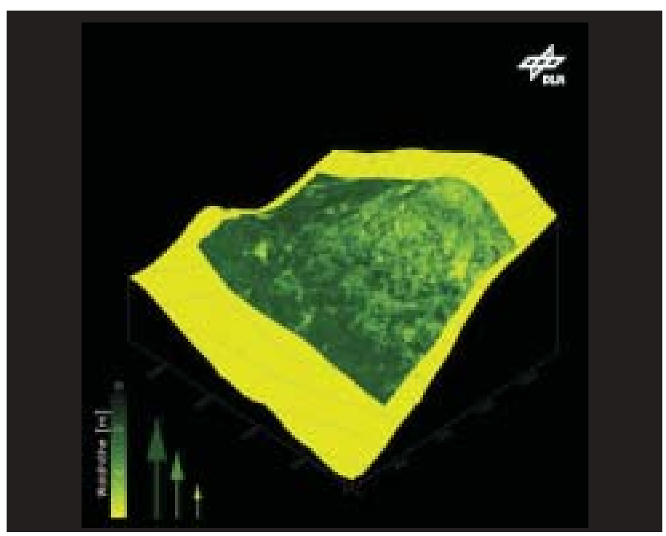

Figure 3: Tree Height and Topography Estimated using L-Band DLR E-SAR Polarimetric Interferometric Data

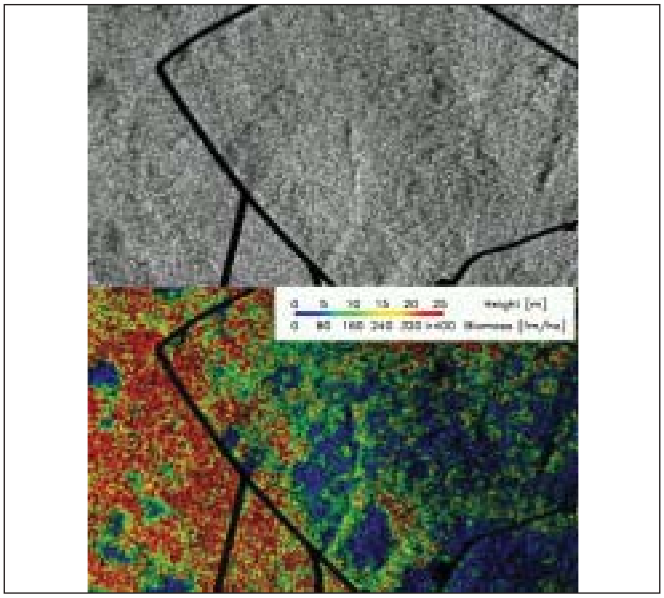

Figure 4: HH RCS image (upper) and radar derived tree height/biomass map for the same scene (lower) (see reference [24])

Conclusions and Future Developments

In this tutorial we have developed as a theme the importance of multi-channel phase in radar remote sensing and used it to support the idea of combining polarisation diversity with interferometry in future radar sensors. Key to success is the generalised coherence or entropy and key to robustness the development of physical models for the interaction of polarised waves with natural surfaces. We have concentrated on one important example, namely tree height and biomass estimation, but there are many other application areas where this technology is being considered. Table I provides a selective survey of different geo-physical parameters and examples of the types of algorithms currently being developed. We can see that polarimetric and/or interferometric phase appears in every area. This table provides a 'snapshot' in time, each area is ongoing in research and development and exciting future technology innovations such as bistatic radar and satellite radar constellations will require parallel improvements in our understanding of the interaction of polarised waves with natural media in order to fully exploit the scientific and commercial potential of radar in remote sensing.

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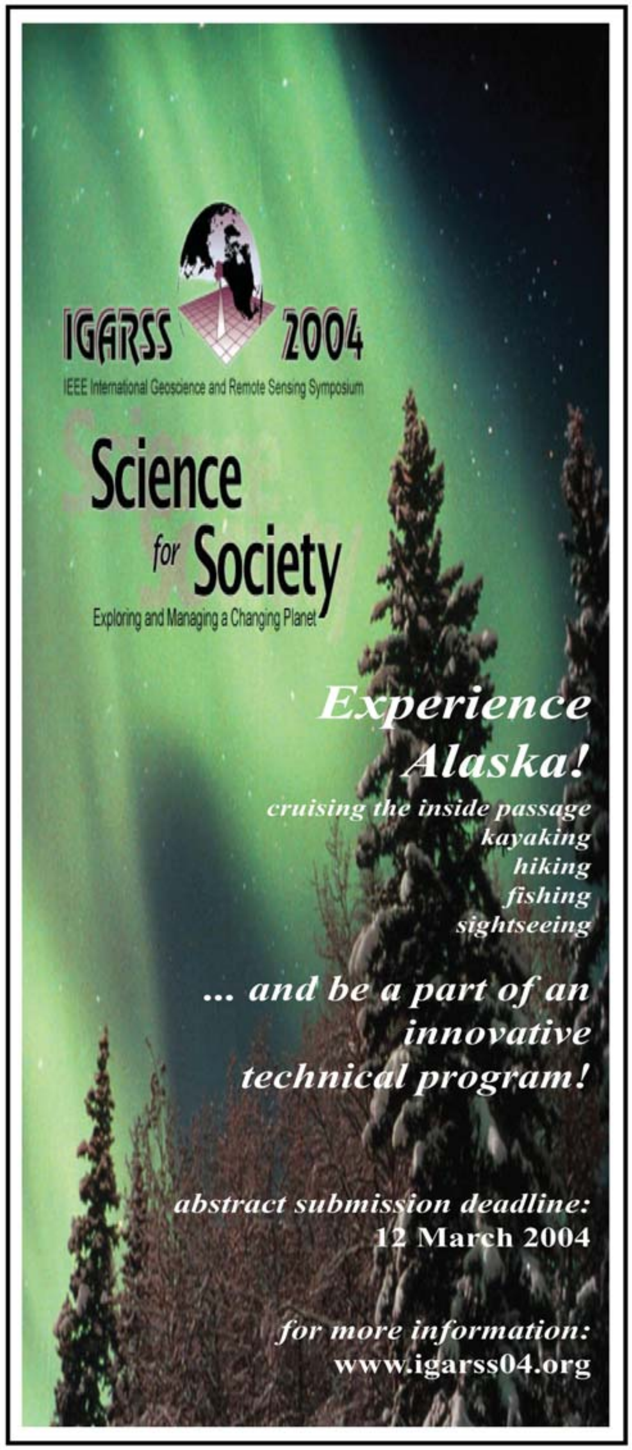
President's Message continued from page 4

our field. The depth and breadth of the GRS-S are evidenced by the selection this year of GRS-S members Profs. Jin Au Kong and Anthony W. England as recipients of two major IEEE awards. Prof. Kong will receive the 2004 IEEE Electromagnetics Award for "contributions to fundamental electromagnetic theory and its advanced applications, especially to remote sensing and geophysical probing." Prof. England will receive the 2004 Judith A. Resnick Award for "significant contributions to the development and application of spaceborne microwave radiometry to remote sensing." Both of these awards will be conferred during the annual Society banquet at the 2004 International Geoscience and Remote Sensing Symposium, to be held in Anchorage this September. Our sincere congratulations are due!

The Society's knowledge base is evidenced by the ten-year anniversary this year of the GRS-S Technical Committees (TCs). It seems hard to believe that a decade has passed since the formation of the TCs at the Pasadena IGARSS in 1994. During this time the TCs have grown significantly in both membership and scope. Our Society now supports five TCs whose scopes collectively span the end-to-end process of remote sensing, that is, from sensor physics to applications or remote sensing, including radio frequency coordination. In fact, the TCs are currently playing a particularly important and central role in the development of the Society's position on global Earth observations – a challenge that has emanated from the historic Earth Observation Summit of 2003. This technical position is being jointly prepared by the GRS-S, Oceans Engineering Society (OES), Aerospace and Electronics Systems Society (AESS), and Sensors Council (SC) to help address needs of the Group on Earth Observations (GEO) that were identified at the Earth Observation Summit. I encourage you to participate in this unique multi-Society effort through the GRS-S Technical Committee of your choosing.

Our Society's technical knowledge base is further reflected by a strong and growing IGARSS. Early submission statistics for the Anchorage IGARSS indicate receipt of nearly 2200 abstracts - a 13% increase in submissions over any previous North American IGARSS. Prof. Verne Kaupp, the General Chair of IGARSS 2004, and I welcome you to attend this year's Symposium. We are looking forward to an excellent event focusing on this year's theme of *Science for Society – Exploring and Managing a Changing Planet.* We hope that you will use the opportunity to not only enhance your own technical knowledge base, but also to discover Alaska via the many excursions that are possible out of and around Anchorage.

In addition to our global character and extensive technical knowledge base, our Society stands tall in the area of member services. Citing just a few noteworthy examples: 1) While TGARS remains our flagship technical journal, the new Geoscience and Remote Sensing Letters provides an alternate medium for technical publication with short turnaround. 2) The Society's Industrial Liaison Group, led by Drs. William Gail and Robert Shuchman, has recently established an electronic Quarterly Newsletter and associated website to promote industry networking. 3) During 2003, our Senior Member Search program, led by our Executive Vice President Leung Tsang, served to facilitate upgrades of 50 IEEE GRS-S members to Senior Member status. My goal is to continue and broaden services such as these so that we stand even taller among IEEE entities during our next review in 2009.



Finally, I wish to congratulate Dr. John Kerekes of the MIT Lincoln Laboratory and his local organizing team for their selection at the recent St. Louis AdCom meeting to host IGARSS 2008 in Boston, Massachusetts. Similarly, congratulations are due to Professor Harold Annegarn and his team for their selection to host IGARSS 2009 in Cape Town, South Africa. We look forward to these exciting events!

Albin J. Gasiewski
President, IEEE GRSS

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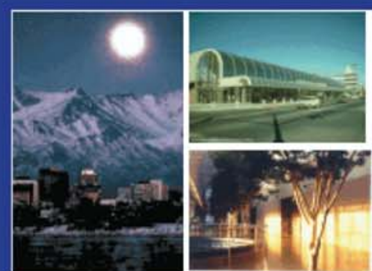

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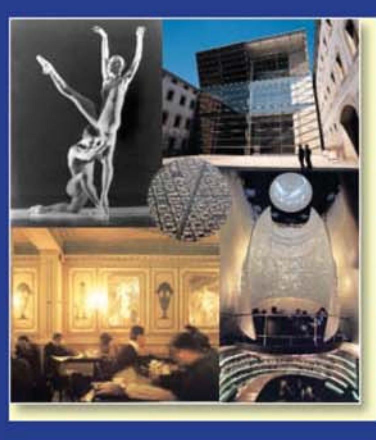

IGARSS'07

Date Pending • Barcelona Spain
Ignasi Corbella, Universitat Politecnica de Catalunya, Barcelona (corbella@tsc.upc.es)
General Chairman

For information on any of the upcoming symposia, please contact IEEE GRSS at grss@ieee.org or visit the society website at http://ewh.ieee.org/soc/grss/

UPCOMING CONFERENCES

See also http://www.techexpo.com/events or http://www.papersinvited.com for more conference listings

Name: **URSI Commission F Open Symposium**
Dates: June 1-4, 2004
Location: Cairns, Great Barrier Reef, Australia
Contact:
Fax: +61-7-3721-6667
E-mail: registration@ursi-f2004.com
URL: http://www.ursi-f2004.com

Name: **10th International Conference on Ground Penetrating Radar**
Dates: June 21-24, 2004
Location: Delft University of Technology, The Netherlands
Contact: Evert Slob
Fax: +31 15 278 1189
E-mail: gpr2004@citg.tudelft.nl
URL: http://www.gpr2004.tudelft.nl

Name: **Specialists Workshop on EM Scattering Modeling and Information Retrieval in Remote Sensing**
Dates: August 25-27, 2004
Location: Fudan University, Shanghai, China
Contact: Professor Ya-Qiu Jin
Fax: + 0086-21-65643902
E-mail: yqjin@fudan.ac.cn
URL:

Name : **2004 IEEE International Geoscience and Remote Sensing Symposium**
Dates : September 20 - 24, 2004
Location: Alaska Egan Convention Center, Anchorage, Alaska, USA
Contact: Lisa Ostendorf
Fax: +1+540-658-1686
E-mail: ieeegrss@adelphia.net
URL: http://www.igarss04.org/

Name: **RADAR 2004**
Dates: October 18-22, 2004
Location: Toulouse, France
Contact: Marc Lesturgie
Fax: +33-1-569-03708
E-mail: radar2004@see.asso.fr
URL: http://www.radar2004.org

Name: **Sensors 2004 Conference**
Dates: October 24-27, 2004
Location: University of Technology, Vienna, Austria
Contact: Michiel Vellekoop
Fax: +43+1+58801 36699
E-mail: wellekoop@iemw.tuwien.ac.at
URL: www.ieee.org/sensors2004

Name: **SPIE Asia-Pacific Remote Sensing Symposium 2004: Conference on Microwave Remote Sensing of the Atmosphere and Environment IV**
Dates: November 8-12, 2004
Location: Honolulu, Hawaii, USA
Contact: Gail Skofronick Jackson
Fax: +1+301-614-5888
E-mail: Gail.S.Jackson@nasa.gov
URL: http://www.spie.org/info/ae

Name: **2nd International Conference on Microwaves, Antennas, Propagations and Remote Sensing**
Dates: November 23-25, 2004
Location: Jodhpur, India
Contact: O.P.N. Calla
Fax: 91-0291-2626166
E-mail: opncalla@yahoo.co.in
URL:

Name: **2004 Asia-Pacific Microwave Conference**
Dates: December 15-18, 2004
Location: New Delhi, India
Contact: Dr. Mridula. Gupta, UDSC
Fax: +91-11-26886606
E-mail: apmc04@bol.net.in
URL: www.apmc04.org.in

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