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GEOSCIENCE and REMOTE SENSING
Newsletter

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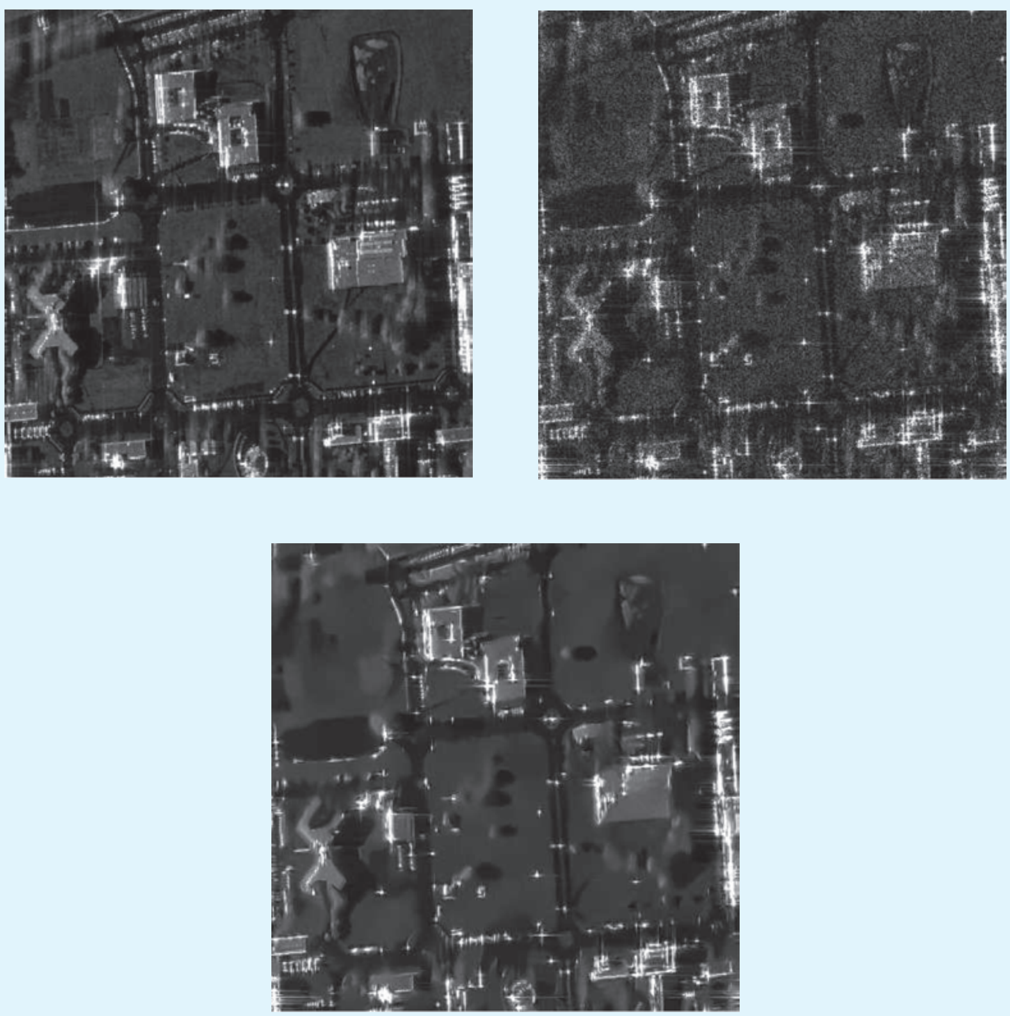

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Table of Contents

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

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Input	April 15	July 15	Oct 15	Jan 15

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This first issue of the IEEE Geoscience and Remote Sensing Newsletter in 2011 contains many interesting articles on various technical areas of remote sensing, as well as contributions on the activities of the IEEE Geoscience and Remote Sensing Society (GRSS). As you probably observed in the past year, there are an increasing number of articles published in each issue. This reflects the growing interest of our community in a publication that addresses technical, educational and industrial relations issues. These issues are of broad interest and are not covered by other GRSS publications. I expect that this trend will continue, and I strongly encourage you to contribute to the success of the Newsletter by submitting technical, educational, and industrial profiles articles that are of interest of our community.

Starting from the next issue, we are going to publish a new column in which we inform the community of the recently completed PhD dissertations in the fields of activity of our society. We plan to print the title of the dissertations, the student's and advisor's names and a very short description of the work, i.e. a few sentences. The electronic version of each thesis will then be available for download from the GRSS web site. This is an important opportunity for young researchers to increase the visibility and impact of their work. It is also a useful initiative for our community to increase the awareness of the most recent research work accomplished by a new generation of engineers and scientists.

This issue of the Newsletter contains two main articles in the *Features* section. The first is a tutorial paper on the analysis of synthetic aperture radar (SAR) images, specifically on the use of image processing techniques for the analysis of SAR data. The article addresses a hot topic in SAR, because the increased availability of very high spatial resolution SAR images (e.g. with the TerraSAR-X and TanDEM-X missions as well as the Cosmo-Skymed constellation) makes it crucial to define effective image analysis methods that can simultaneously deal with i) speckle, ii) highly detailed data with improved range and azimuth resolutions, and iii) complexity of object scattering at meter-scale resolution. The second

(continued on page 4)

President's Message

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On behalf of the IEEE Geoscience and Remote Sensing Society, I would like to thank our Past President Alberto Moreira for his dedication, hard work and outstanding leadership over the past year. The excellent IGARSS in Honolulu, the growth in GRSS chapters, our outstanding publications and the new GRSS webpage introduced in 2010 are just a few examples of our success.

Unfortunately, at the beginning of this year the GRSS community received sad news. The GRSS' long-serving Education Director Granville Paules died in the evening of January 4th in Washington DC after a long battle with cancer. The passing of Gran Paules is a great loss for the GRSS. He was highly respected professionally and had a major impact on the remote sensing community through his work with NASA, Kelly Anderson & Associates and the GRSS. Gran and his wife Diane, who often accompanied him to meetings, were very popular in the GRSS community. As GRSS Education Director, he was committed to advancing delivery of conferences and tutorials through the use of web technology. He was also instrumental in increasing NASA's engagement with the GRSS. Gran will be sorely missed. On behalf of the GRSS AdCom, I send my deepest condolences to Diane and his family.

Many important activities are on the agenda of the GRSS in 2011, including our annual premier conference, IGARSS, which will be held July 31 through August 5. The

(continued on page 38)

Cover Information: Illustration of the NL-means SAR denoising (see article starting at page 10). Top-left figure is a 100-looks image obtained by multi-looking a Very High resolution image (image acquired by ONERA, multilooked by CNES ©ONERA ©CNES). This image can be considered as a ground truth. Top-right figure is a 1-look image of resolution 1×1 meter. Bottom figure is the denoised version of the 1-look image. Fine details are well preserved by this approach.

(*Editor's Comments continued from page 3*)

main feature article addresses the reuse in new missions of software that was developed for past and current satellite missions. This article gives the NASA perspective on a topic of great importance because of its implications for both the proper use of existing software tools (and of the related know-how) and the cost savings from the reuse of software assets.

The *Reports* section contains two main contributions. The first is an article describing the results of the IGARSS 2010 survey. IGARSS is the premier conference organized by the IEEE GRSS. In 2010 the 30th anniversary IGARSS was held in Honolulu, Hawaii, USA, attracting nearly 2000 participants. Therefore, it was an excellent opportunity for a web-based survey to assess the degree of satisfaction of the IGARSS participants and to identify possible improvements on the basis of the survey comments. The *Reports* section also contains a report on the *2nd Workshop on Hyperspectral Image and Signal Processing – Evolution in Remote Sensing* (WHISPERS 2010), which was held at the campus of the University of Iceland, Reykjavik, Iceland, June 14–16, 2010.

The *Chapters Corner* section contains two contributions. The first article describes the outstanding activities of the French Chapter, which was awarded the Chapter Excellence Award for its important initiatives and activities during 2009. Congratulations to the French Chapter Chair and members for this award! The second article in the Chapters Corner is a brief introduction of the GRSS Joint Chapter of the Australian Capital Territory and New South Wales Sections. This is one of the new Chapters recently approved by IEEE and is the first GRSS Chapter in Australia.

The *Industrial Profiles* column introduces the Ball Aerospace & Technologies Corp., which is one of the industry leaders in the field of remote sensing. The article describes the field of activities of Ball Aerospace and focuses on some of the key technologies and sensors that this company offers to the remote sensing scientific and user community.

I would also like to draw your attention to the various calls for nominations reported in this issue. It is very important that GRSS members contribute to identify outstanding candidates for the variety of awards that are given each year by GRSS and by our sister societies. Once again, I would emphasize the call for applications for elevation to IEEE senior member. There are many engineers and scientists among our Society Members who meet the eligibility criteria but are not yet Senior Members. I encourage them all to apply and all IEEE GRSS Senior Members to nominate eligible colleagues for this valuable recognition.

Finally, recently the GRSS Administrative Committee approved changes to the GRSS Bylaws. These changes are required to appear in the GRSS Newsletter and therefore are reported in this issue starting from page 38. The changes will go into effect unless ten percent of the Society members object within 30 days of publication.

I wish everyone an enjoyable and productive Spring.

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GRSS MEMBER HIGHLIGHTS

GRSS MEMBERS ELEVATED TO THE GRADE OF IEEE FELLOW FOR 2011

Donald Barrick *"for development of high frequency radars and applications"*

Adriano Camps *"for contributions to microwave remote sensing of land and sea surfaces"*

Paul Gader *"for contributions to computational intelligence algorithms for landmine and explosive object detection"*

Maria Greco *"for contributions to non-Gaussian radar clutter modeling and signal processing algorithms"*

Arun Hampapur *"for contributions to video indexing, video search and surveillance systems"*

Anthony Milne *"for leadership in remote sensing applications"*

Eric Mokole *"for leadership and contributions to ultra-wideband radar, waveform diversity, and transionospheric space radar"*

Eric Pottier *"for contributions to polarimetric specific absorption rate"*

Paul Rosen *"for contributions to Earth and planetary radar remote sensing"*

Masanobu Shimad *"for contributions to radar remote sensing technologies"*

GRSS MEMBERS ELEVATED TO THE GRADE OF SENIOR MEMBER DURING THE PERIOD NOVEMBER 2010–FEBRUARY 2011

November:	Donato	Flores	Peru Section
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You can also visit the GRSS website: http://www.grss-ieee.org

CALL FOR NOMINATIONS FOR THE GRSS ADMINISTRATIVE COMMITTEE

The Nominations Committee calls upon our membership to nominate members to serve on the GRSS Administrative Committee (AdCom). The GRSS AdCom consists of 18 elected persons, each of whom serves for three years. Their terms are overlapping to ensure continuity. Additional information on the society and the AdCom is available at http:// www.grss-ieee.org/.

In nomination petitions, the procedure described below is to be followed. Such nominations petitions must be made by May 29, 2011.

i) A nominating petition carrying a minimum of 2% of the names of eligible Society members (~50), excluding students, shall automatically place that nominee on the slate.

ii) Prior to submission of a nomination petition, the petitioner shall have determined that the nominee named in the petition is willing to serve if elected; and evidence of such willingness to serve shall be submitted with the petition.

iii) Candidates must be current members of the IEEE and the GRSS.

iv) Petition signatures can be submitted electronically through the Society website, or by signing and mailing a paper petition. The name of each member signing the paper petition shall be clearly printed or typed. For identification purposes of signatures on paper petitions, membership numbers or addresses as listed in the official IEEE membership records shall be included. Only signatures submitted electronically through the Society website or original signatures on paper petitions shall be accepted.

v) A brief biography of the nominee, similar to that used for TGARS authors, but not to exceed one page, will be required

vi) The nominating petition is to be submitted to the GRSS Nominations Committee, c/o Prof. Leung Tsang, IEEE GRSS Nominations Chair, Box 352500, Department of Electrical Engineering, University of Washington, Seattle, WA 98195, USA. E-mail: tsang@ee.washington.edu.

In addition to the candidates from nomination petitions, the Nominations Committee may choose to include a name on the slate regardless of the number of names generated by the nominating petition process. The slate derived by the Nominations Committee shall be presented to the Society membership at large via mail ballot, and the three candidates receiving the greatest number of votes shall be elected. The Administrative Committee shall hold an Annual Meeting in November 2011, after results of this vote are known, at which time elections will be held to fill the remaining three regular vacancies in the Administrative Committee, with all successful candidates to start on January 1, 2012.

NOMINATIONS FOR IEEE MEDALS AND RECOGNITIONS

The IEEE Awards Program provides peer recognition to technical professionals whose exceptional achievements and outstanding contributions have made a lasting impact on technology, society, and the engineering profession.

The IEEE Geoscience & Remote Sensing Society members may be particularly interested in the following IEEE Medals and Recognitions, whose nomination deadlines are 1 July 2011. The awards typically consist of a medal, certificate and honorarium and are presented at the distinguished IEEE Honors Ceremony.

- **IEEE Medal of Honor**, for an exceptional contribution or an extraordinary career in the IEEE fields of interest.
- **IEEE Founders Medal**, for outstanding contributions in the leadership, planning, and administration of affairs of great value to the electrical and electronics engineering profession.
- **IEEE James H. Mulligan, Jr. Education Medal**, for a career of outstanding contributions to education in the fields of interest of IEEE.
- **IEEE John von Neumann Medal**, for outstanding achievements in computer-related science and technology.
- **IEEE Jack S. Kilby Signal Processing Medal**, for outstanding achievements in signal processing.
- **IEEE Dennis J. Picard Medal for Radar Technologies and Applications**, for outstanding accomplishments in advancing the fields of radar technologies and their applications.
- **IEEE Service Awards**
- **IEEE Corporate Recognition Awards**
- **IEEE Honorary Membership**

Awards presented by the IEEE Board of Directors fall into several categories: The Medal of Honor, Medals, Technical Field Awards, Corporate Recognitions, Service Awards, and Prize Papers. The IEEE also recognizes outstanding individuals through a special membership category: IEEE Honorary Member.

Nominations are initiated by members and the public, and then reviewed by a panel of peers. Their recommendations are submitted to the IEEE Awards Board prior to final approval by the IEEE Board of Directors.

For nomination guidelines and forms, visit http://www.ieee.org/awards. Questions? Contact IEEE Awards Activities, 445 Hoes Lane, Piscataway, NJ 08854 USA; tel.: +1 732 562 3844; fax: +1 732 981 9019; e-mail: awards@ieee.org.

COMPLETE LIST OF IEEE MEDALS AND RECOGNITIONS

IEEE Medal of Honor, for an exceptional contribution or an extraordinary career in the IEEE fields of interest.

IEEE Edison Medal, for a career of meritorious achievement in electrical science, electrical engineering or the electrical arts.

IEEE Founders Medal, for outstanding contributions in the leadership, planning, and administration of affairs of great value to the electrical and electronics engineering profession.

IEEE James H. Mulligan, Jr. Education Medal, for a career of outstanding contributions to education in the fields of interest of IEEE.

IEEE Alexander Graham Bell Medal, for exceptional contributions to the advancement of communications sciences and engineering.

IEEE Simon Ramo Medal, for exceptional achievement in systems engineering and systems science.

IEEE Medal for Environmental and Safety Technologies, for outstanding accomplishments in the application of technology in the fields of interest of IEEE that improve the environment and/or public safety.

IEEE Medal for Innovations in Healthcare Technology, for outstanding contributions and/or innovations in engineering within the fields of medicine, biology and healthcare technology.

IEEE Medal in Power Engineering, for outstanding contributions to the technology associated with the generation, transmission, distribution, application and utilization of electric power for the betterment of society.

IEEE Richard W. Hamming Medal, for exceptional contributions to information sciences, systems and technology.

IEEE John von Neumann Medal, for outstanding achievements in computer-related science and technology.

IEEE Jack S. Kilby Signal Processing Medal, for outstanding achievements in signal processing.

IEEE Jun-ichi Nishizawa Medal, for outstanding contributions to material and device science and technology, including practical application.

IEEE Dennis J. Picard Medal for Radar Technologies and Applications, for outstanding accomplishments in advancing the fields of radar technologies and their applications.

IEEE Robert N. Noyce Medal, for exceptional contributions to the microelectronics industry.

IEEE/RSE (Royal Society of Edinburgh) Wolfson James Clerk Maxwell Award, for groundbreaking contributions that have had an exceptional impact on the development of electronics and electrical engineering or related fields.

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- **IEEE Corporate Innovation Recognition**, for outstanding and exemplary contributions by an industrial entity, governmental or academic organization, or other corporate body, which have resulted in major advancements in electrotechnology.
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FEATURES

HOW ADVANCED IMAGE PROCESSING HELPS FOR SAR IMAGE RESTORATION AND ANALYSIS

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I. Overview

The past few years have seen important advances in remote sensing imagery. The new sensors have improved resolutions in all dimensions, spatial resolution with reduced pixel sizes, temporal resolution with shorter revisit times and spectral resolution with increased number of spectral bands. With these new specifications, new challenges have appeared. The huge amount of remote sensing data raises new computational issues [1] and asks for faster processing approaches. New applications are accessible or can achieve new results like change detection, natural disaster monitoring, urban and landscape planning, biomass measurement. Theses advances are especially true for Synthetic Aperture Radar (SAR) sensors, with metric resolution available for civil satellite data, new spectral bands (L band with ALOS, X band for TerraSAR-X and COSMO-SkyMed), new interferometric potential thanks to TanDEM-X [2], reduced revisit time with constellations like COSMO-SkyMed. In spite of these improvements, SAR images remain difficult to interpret. New difficulties arose with the increase of spatial resolution: previously unnoticeable targets are now visible, bright scatterers are more numerous. Beyond speckle noise intrinsic to coherent imagery, geometric distortions due to distance sampling limit our visual understanding of such images, and direct interpretation of an urban area imaged by a SAR sensor is still reserved to expert photo-interpreters.

Together with progress made with recent sensors, new powerful image processing methods have emerged in the recent years. Among the major advances made last decade by the image processing and computer vision communities, we have chosen to emphasize three of them for their long-term potential and applicative interest for SAR imaging.

The first family of advances in signal and image processing is related to the progress in statistical modeling of multiplicative noise, which is particularly important to deal with SAR imagery. Therefore, the first point we would like to mention is the Mellin framework proposed in [3] to deal with positive random variables and their multiplication.

The second family of methods is based on the idea of "patches". Patches are small image parts (typically 5×5 or 7×7 pixels). They capture fine scale information such as texture, bright dots or edges. Given their very local extent, they are highly redundant, i.e., many similar patches can be found in an image. These similar patches can then be combined to reduce noise [4]. But patch similarity can also be applied to stereovision or change detection.

The third family are the "graph-cut" approaches, where an image processing problem is converted into the search of a minimum cut in a graph [5]. Efficient minimum cut algorithms have been proposed for computer vision problems [6] and the focus is put on designing a graph to solve a given image processing task. Theses approaches have been mainly used to optimize functionals or energies derived from Markovian modeling or regularization approaches. A famous model is the Total Variation minimization [7] which can be exactly minimized in one of its discrete form using a multiple layers graph [8], [9]. Graph-cut based approaches have also become very popular for many denoising and partitioning problems.

We will see in this paper how these three theories (among others) have contributed to the development of efficient tools for SAR image processing.

II. SAR Data Statistical Modeling

One of the main difficulties of SAR imagery is the speckle phenomenon. Radar are coherent imagery systems, leading to interferences between electromagnetic waves backscattered by the reflectors inside a pixel. These interferences cause a strong variability of radiometric values, even for a physically homogeneous area. In his seminal work [10], Goodman has derived the gray level distributions of radar images: Rayleigh distribution of amplitude image, Nakagami for multilooked data (multilook meaning that some pixels have been averaged), Gamma for multilooked intensity image. However, these models have shown some limits when dealing with high resolution images. Since the beginning of SAR images, many distributions have been proposed to model radar data: K distribution [11], log-normal distribution, Weibull distribution, etc. These distributions can be well adapted to some specific cases. They are usually defined by some parameters that have to be empirically learnt on some small local areas of the images. The tradeoff between bias and variance of the estimators requires large window sizes while keeping a homogeneous statistical population.

In the past recent years, a powerful framework has been developed by J.-M. Nicolas to unify the set of distributions

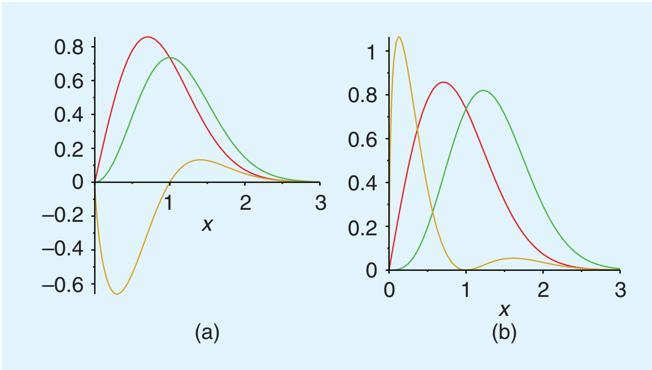

Figure 1. This figure illustrates the interest of the log-moment and log-cumulant derived from the Mellin framework. In the case of moment computation, the distribution is multiplied by x^k before integration. This multiplication increases the importance of the tail of the distribution when k increases. Yet the tail can be strongly disturbed by bright scatterers producing wrong parameter estimates. With the log-cumulant estimator, both head and tail of the distribution are taken into account, giving more robust estimates. (a) Moments of order 1: distribution of the amplitude $p_A(x)$ in red, of $xp_A(x)$ (green) and $\log(x)p_A(x)$ (yellow). (b) Moments of order 2: distribution of the amplitude $p_A(x)$ in red, of $x^2p_A(x)$ (green) and $\log(x)^2p_A(x)$ (yellow).

and to provide efficient tools to compute parameter estimators [3]. The whole theory is built on the observation that radar amplitude or intensity is intrinsically positive. Therefore, the Fourier transform, which is an integral over the set of all real values, should be replaced by some transform defined on positive values only. This is the case of the Mellin transform, which has the following form:

$$\Phi(s) = \int_0^{+\infty} x^{(s-1)} p(x) dx$$

where s is a complex number, and p stands here for the random variable distribution. Mimicking the characteristic function and all the definitions that can be derived from it, like moments and cumulants, a second kind characteristic function based on Mellin transform has been defined, leading to log-moments and log-cumulants. The Mellin convolution, which is the counterpart of the convolution in the positive value domain, provides a natural way to define the distribution of products of independent random variables (whereas the regular convolution deals with sum of variables). Without going too far into the details of this still evolving theory, we would like to mention what seems to us important contributions of this work. First, parameter estimation based on log-cumulants gives low variance estimators, allowing the use of analysis windows of reduced sizes (figure 1). Secondly, this work has enlightened the relationships between the different distributions (Gamma, K, inverse Gamma, Weibull, log-normal,...) thanks to Mellin convolution and thanks to a diagram defined by the second and third log-cumulants (figure 2). Thirdly, the Fisher distribution has appeared as a "generic" distribution with 3 parameters adapted to a wide range of surfaces (urban areas, vegetation, etc.) [12].

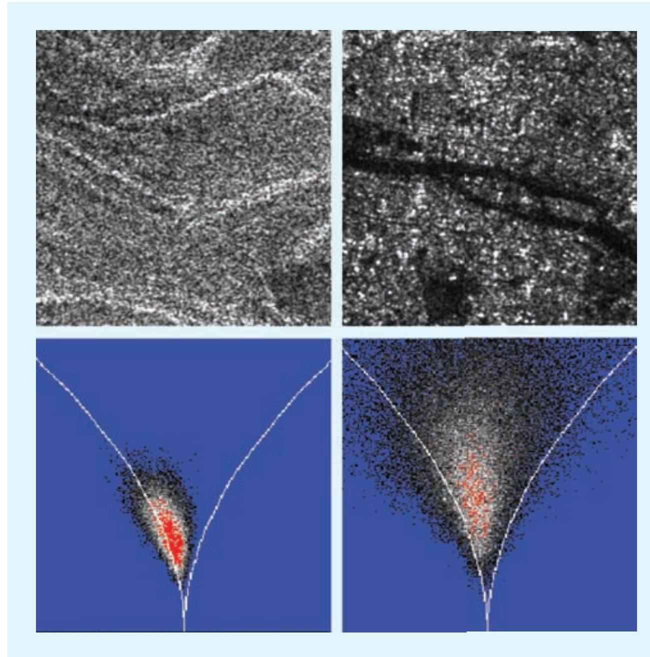

Figure 2. The κ_2–κ_3 representation gives the positioning of the distributions in the log-cumulant space (axes are the second and third log-cumulant). Specific curves represent the Gamma and inverse Gamma distributions (in white on the bottom figures, respectively on the left and on the right), whereas the log-normal distributions are represented by the vertical axis. In this figure, two original 3-looks ERS data are represented on the top, on the left for a vegetation area, and on the right for an urban area. In the bottom, for each image, the local parameters are computed on 11 × 11 windows giving a point in the κ_2–κ_3 space. We can observe that for these two images their representations do not correspond to the same distributions. The vegetation areas are situated near the Gamma axis, whereas urban areas are spread in the middle part of the diagram corresponding to Fisher and log-normal distributions.

This work has been first developed for amplitude or intensity images, and has been adapted later by different authors to polarimetric data. We would like to mention the work of Anfinsen on the extension of the use of Mellin transform for polarimetric data by developing the matrix-variate Mellin transform framework, and exploiting it to better process polarimetric data [13].

III. SAR Data Denoising

Whereas the Mellin framework takes into account the variability of the scene within a region with a variety of

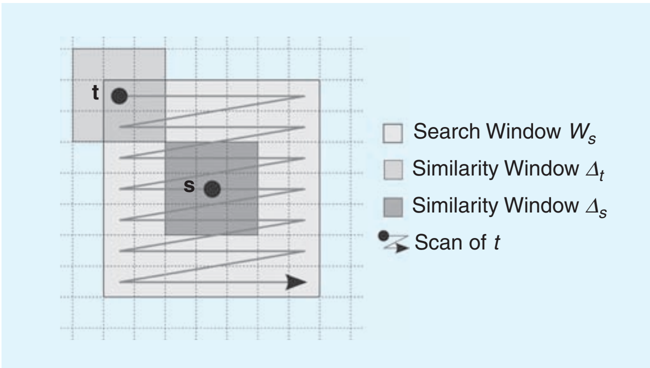

Figure 3. The idea of non-local means is to denoise pixel s using the weighted value of pixel t. The weight of pixel t is computed by comparing the surrounding patch of s and the surrounding patch of t. Pixels t are considered in a search window W_s. Figure extracted from [16].

distributions seen as Mellin products, denoising approaches try to suppress signal-dependent speckle variability to recover the scene reflectivity.

Non-local approaches and graph-cut based optimization have proven to lead to very efficient denoising methods. We will illustrate in this section how these recent and popular image processing approaches can be adapted to the case of SAR images.

A. Non-Local Approaches

The first family of methods described in the introduction is based on patch similarity. They are known as non-local approaches or NL-means [4]. The main idea of non-local methods is to find similar patches in the image. In the case of image denoising, this set of similar patches is then used to suppress the noise, for instance by averaging the central pixels of each patch.

Let us consider the Gaussian filter for comparison. Its principle is to average spatially close pixels to suppress the noise. Spatially close pixels can belong to different populations, though. Therefore, improvements of this basic idea have been proposed. Instead of taking "spatially close" pixels, we can take "radiometrically close" pixels [4]. In this case, the problem is to select a pixel which should be "radiometrically" close from another pixel. And here comes the idea of patch comparison. A pixel can reasonably be assumed to be radiometrically close from another one, if their surrounding patches are similar (see figure 3). To denoise a pixel s, the values of pixels t are averaged with a weight depending on the similarity of the two patches surrounding s and t. This is a powerful approach since there is no connectivity constraint between s and t compared to [14], [15], and far apart patches can be considered to denoise a given pixel (hence the term "non-local" denoising).

This framework has been initially developed for Gaussian noise: the denoising is done by averaging the noisy samples, and the similarity criterion is based on the Euclidean distance between the two patches. To adapt this framework to other kinds of noise while keeping the principle of patch comparison, Deledalle et al. have proposed a probabilistic framework [16]. The denoising task is expressed as a weighted maximum likelihood estimation, and the weight definition is established thanks to a probabilistic approach. Besides, this probabilistic framework leads to similarity weights formed by two terms, one related to the noisy data (likelihood similarity) and the other one to the denoised data (prior similarity). For this second term, an iterative scheme has been proposed which greatly improves the results when strong noise is present on the data.

This framework can be applied to any noise having a known distribution like Gamma or Poisson. In the case of SAR amplitude images, the denoising scheme is the following:

- the denoising of pixel s can be written as:

$$\hat{R}_s^{(WMLE)} = \frac{\sum_t w(s,t) A_t^2}{\sum_t w(s,t)}$$

  where A_s is the amplitude of pixel s and $\hat{R}_s$ is the searched for reflectivity.
- the weight at iteration i is computed as :

$$w(s,t)^{(i)} = \exp\left[-\sum_k \left(\frac{1}{\tilde{h}} \log\left(\frac{A_{s,k}}{A_{t,k}} + \frac{A_{t,k}}{A_{s,k}}\right) + \frac{L}{T} \frac{|\hat{R}_{s,k}^{i-1} - \hat{R}_{t,k}^{i-1}|^2}{\hat{R}_{s,k}^{i-1}\hat{R}_{t,k}^{i-1}}\right)\right].$$

where $A_{s,k}$ is the amplitude of the kth pixel of the patch centered on s, $\tilde{h} = h/(2L-1)$, L is the number of looks, h and T are two parameters that can be set automatically [17], and i is the iteration.

The final algorithm is thus rather simple and results are interesting, with preserved edges and smoothed areas as can be observed on figure 4.

Other efficient denoising methods have been proposed in the recent years like wavelet based methods [18]–[20] or BM3D based approaches [21]. One of the strengths of the proposed probabilistic framework is that it allows the application of non-local methods for *complex data* or *vectorial data* as soon as noise is well modeled by a parametric distribution. Thus, it can be used efficiently to process interferometric or polarimetric data using the speckle noise described by a zero-mean complex circular Gaussian distribution [10]. For instance in the case of interferometric images, weighted likelihood estimators for reflectivity, interferometric phase and coherence are derived, and the weights measure the probability that the observations come from the same parameters for all the couples of pixels of the two patches. Figure 5 illustrates the potential of such approaches. Instead of computing local hermitian products to derive interferometric information and thus losing spatial resolution, such approaches can be used to

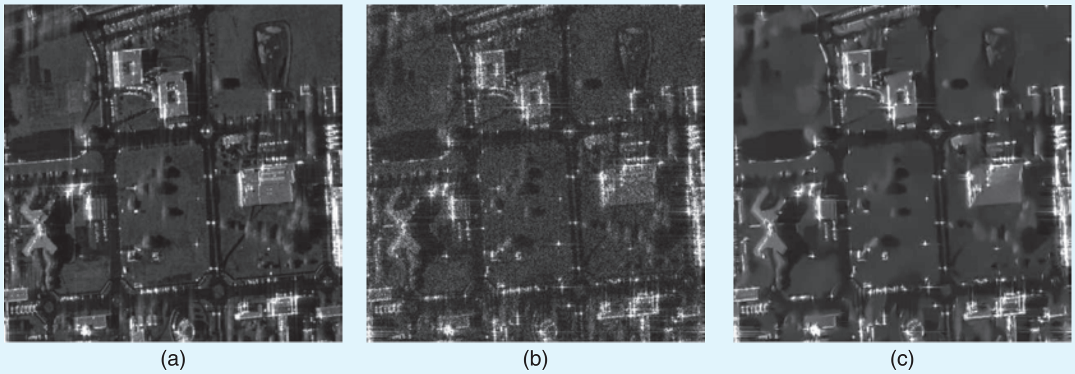

Figure 4. Illustration of the NL-means SAR denoising. Figure a) on the left is a 100-looks image obtained by multi-looking a Very High resolution image (image acquired by ONERA, multilooked by CNES ©ONERA ©CNES). This image can be considered as a ground truth. Figure b) is a 1-look image of resolution 1 × 1 meter. Figure c) is the denoised version of the 1-look image b). Fine details are well preserved by this approach.

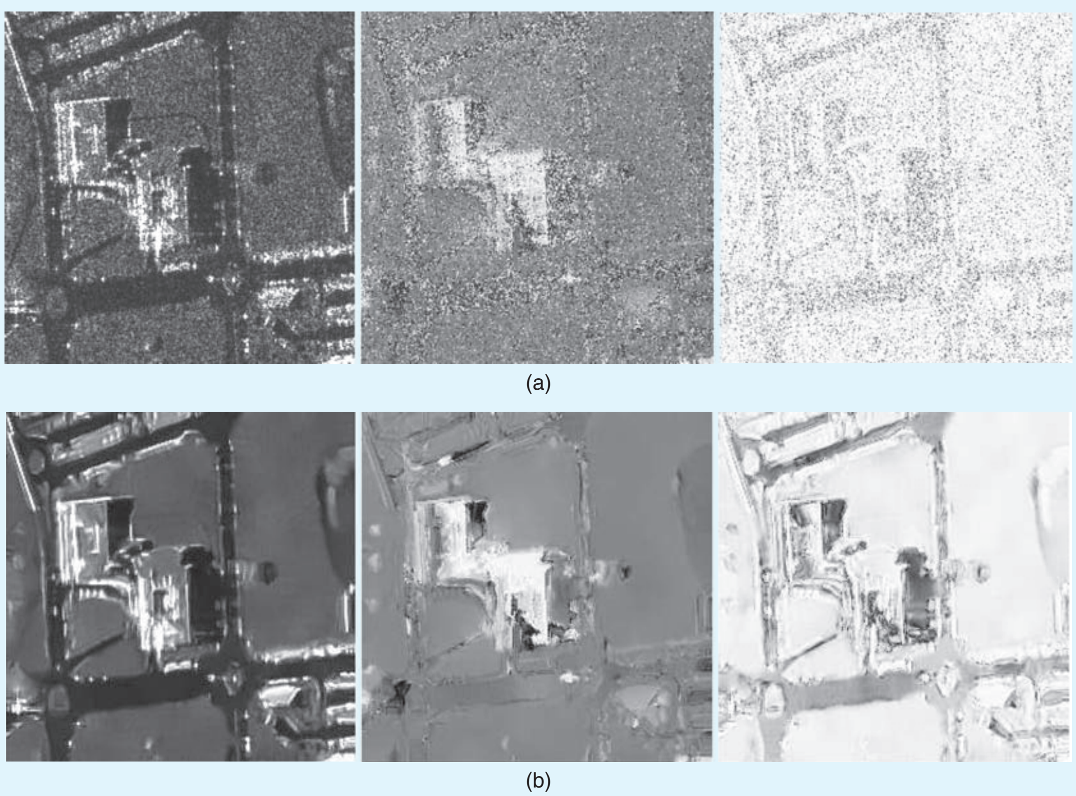

Figure 5. Illustration of NL-InSAR. (a) the original interferometric data (amplitude, phase and coherence, with 1-look). (b) the non-local estimation of amplitude, phase, and coherence with no loss of resolution.The weights of the likelihood estimations are computed using the similarity of the complex patches of the two interferometric images. Results are from [17].

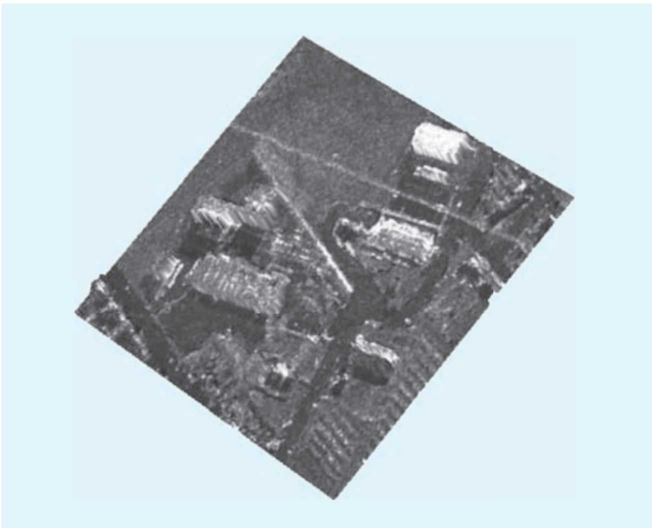

Figure 6. Example of 3D reconstruction using the regularized interferometric phase with a joint prior with amplitude data, and graph-cut optimization (from [28]). The amplitude image is superimposed on the computed elevation (images acquired by ONERA).

compute interferograms at the nominal resolution of the data. The case of polarimetric data is similar with the estimation of the underlying covariance matrix. Application of such a framework is described in [22].

Beyond the denoising application, patch similarity of amplitude, interferometric or polarimetric data can be very useful for change detection or movement monitoring.

B. Regularization Approaches

Other powerful approaches for denoising are regularization based methods which have also been extensively studied in the past 10 years in the image processing and computer vision communities. The idea is to express the problem as an energy minimization one, the energy being divided into two terms, one related to the noise distribution (likelihood term) and the other one to the properties we expect for the solution (prior term). This energy can be derived for instance by a probabilistic approach (discrete point of view), but also from variational methods establishing a functional to minimize (continuous point of view). The likelihood term is usually linked to the model of noise perturbating the data. The prior term or regularization term usually imposes the "smoothness" of the solution and is expressed through interactions between neighboring pixels. A popular model is a low total variation (TV model [7]) corresponding to almost piecewise constant image or equivalently to a sparse gradient (only few values of the gradient can be non zero). But other models like truncated quadratic or phi-functions can be chosen [23].

Beyond the difficult choice of the right model to express our prior knowledge on the scene, the minimization of the energy or functional is generally not easy. Indeed, for many cases, and especially for radar imagery, the neg-log-likelihood is not convex. In this case, usual continuous optimization methods similar to gradient descent can not be applied or risk to get stuck in a local minimum. Recent approaches of combinatorial optimization based on graph-cut allow for exact optimization of energies composed of a convex prior term (like TV minimization) and a (possibly non-convex) data term [8], [9]. Theses approaches build a multiple layer graph, each layer corresponding to a possible gray level of the solution and search for the minimum cut in this graph. The minimum cut gives the *exact* solution of the optimization problem in the discrete space (spatially discrete image and discrete gray level set). There are two main limitations to this important result. The first one is the quantization of the gray levels which may not be easy for high dynamic images like SAR data. It can be solved by combining a discrete optimization step and a continuous one [24]. The second limit is the memory size. Indeed, the size of the graph is the size of the image multiplied by the number of considered gray levels and it should be stored in memory for the minimum cut computation. This size is prohibitive for remote sensing images and block cutting is not an acceptable solution. Recent approaches based on multi-label partition moves [25] or dichotomy [26] largely reduce the memory cost, but loosing the optimality guarantee.

These models can bring interesting results for SAR imagery. The first application is the amplitude denoising of a radar image. In this case, adapted prior can be defined. In [27], the scene is decomposed as the sum of two terms, a component with low total variation representing the "background" of the scene in a cartoon-like model, and a sparse component representing the bright scatterers of the image with few non zero pixels. This model can be solved exactly using graph-cut optimization.

Another interesting application is the joint regularization of phase and amplitude of InSAR data [28]. In this case, it is possible to take into account the exact distribution of the M-look interferometric data for the likelihood term, and to introduce some prior knowledge preserving simultaneously phase and amplitude discontinuities. The phase and amplitude information are hopefully linked since they reflect the same scene. Amplitude discontinuities thus usually have the same location as phase discontinuities and conversely. To combine the discontinuities, a disjunctive max operator has been used, providing well preserved fine structures [28]. Figure 6 shows an example of 3D reconstruction using a joint regularization of the interferometric phase.

These approaches can also be particularly useful for multichannel phase unwrapping [29]. Indeed, they provide a very efficient way to combine different interferometric phases in a multi-modal likelihood term, whereas a regularization term imposes to the unwrapped phase some smoothness constraints. It is also possible to introduce atmospheric corrections in the optimization scheme in an iterative way. These approaches could provide a highly flexible framework to introduce prior knowledge in Digital Terrain Model reconstruction in multi-channel interferometry or in ground movement monitoring in differential interferometry [30]. Figure 7 illustrates the global combination of multi-baseline interferograms with automatic atmospheric corrections using an affine model of phase variation with elevation [31].

IV. Discussion and Conclusion

We have tried to illustrate in the previous sections how advanced image processing methods which have been recently developed by the computer vision community can help SAR image processing. We have focused on three of them, distribution modeling, non-local methods, regularization approaches with graph-cut optimization. Of course, the cited references are far from being exhaustive on these different subjects and other methods like wavelets-based methods would have deserved a more detailed presentation.

Another recent and powerful theory which might well have a great impact in the coming years is compressive sensing [32], [33]. This theory has shown that, despite Shannon theory, for many signals only few measurements are required to allow a faithful reconstruction, provided the signal has a sparse representation in a suitable space (i.e., few non-zero coefficients in that representation). Reconstruction of sparse signals has a long history in radar literature. Recent results in compressed sensing have fueled several works in the areas of compressed SAR acquisitions systems [34], SAR tomography [35] and for SAR GMTI data [36] to cite only a few. We refer the reader to the recent review [37] for more on this very active subject.

Nevertheless, whatever the progress for low-level tasks such as denoising, it is unlikely that they will allow SAR image understanding without high level methods. The influence of geometric configurations combined with distance sampling is predominant on the appearance of the objects in the image. Therefore, a step of object recognition highlighting the relationship between the different signals is usually necessary to fully understand SAR information. Many works have been led in this direction like [38] for optical data, or [39], [40], [41] exploiting jointly SAR and optical images, or an external database. The object level that could be available with metric resolution is still difficult to reach with SAR images on their own. Dictionaries and learning methods could provide some keys for the next step of understanding.

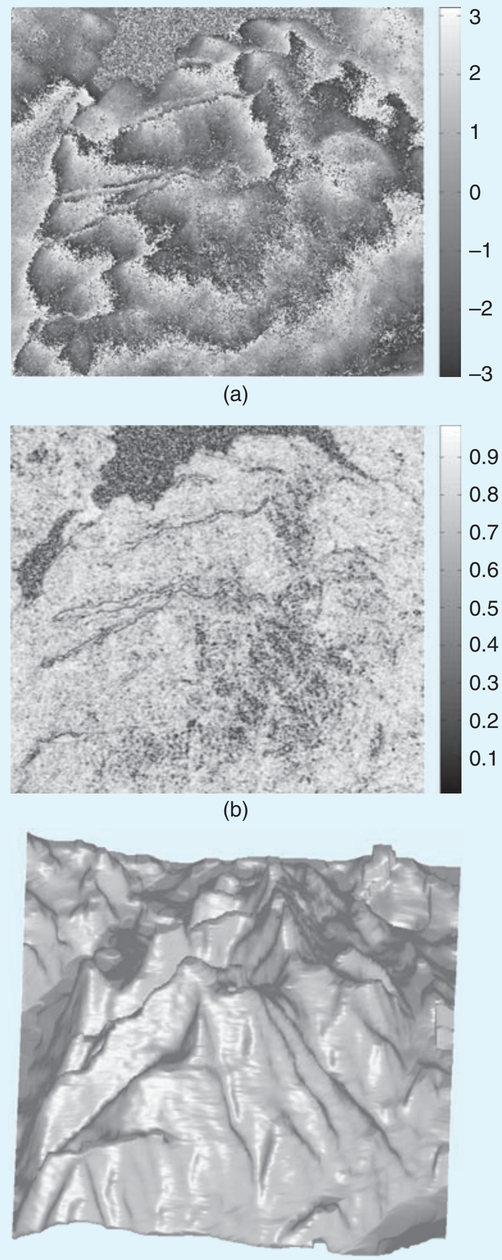

Figure 7. Illustration of the regularization approaches for DTM reconstruction: (a) one of the interferometric phase, (b) associated coherence (acquired by ERS2), and (c) 3D visualization of the DTM. In this case, 6 interferograms with different baselines have been used. The regularization model is TV minimization and an iterative estimation of atmospheric corrections is done.

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TOOLS TO SUPPORT THE REUSE OF SOFTWARE ASSETS FOR THE NASA EARTH SCIENCE DECADAL SURVEY MISSIONS

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I. Introduction

The future Earth science missions at the National Aeronautics and Space Administration (NASA) promise to provide an explosion of data and a platform for science that previously was unachievable using existing hardware, software, and assets. Instrument resolution is increasing, as is the ability of software and hardware to deal with data volumes that will easily grow to the 10–100 petabyte range in the next five years [1]. Over the past twenty years, NASA has invested in software to support all phases of the Earth science mission pipeline. These investments include components and architectures that support science data processing at Science Investigator-led Processing Systems (SIPS), data archival and dissemination at the Distributed Active Archive Centers (DAACs), and ad-hoc data analyses and custom product generation using DAAC-provided data [2]. This general flow is shown in Fig. 1.

For example, the Moderate Resolution Imaging Spectroradiometer (MODIS) Data Processing System (MODAPS) has evolved over time to support higher data processing rates and the production of data products for additional Earth-observing instruments by enhancing its architecture [3]. In addition, several recent efforts [4] to standardize process management and control for both the Orbiting Carbon Observatory (OCO) missions, as well as the NPOESS Preparatory Project (NPP) joint NASA–NOAA–DOD missions,

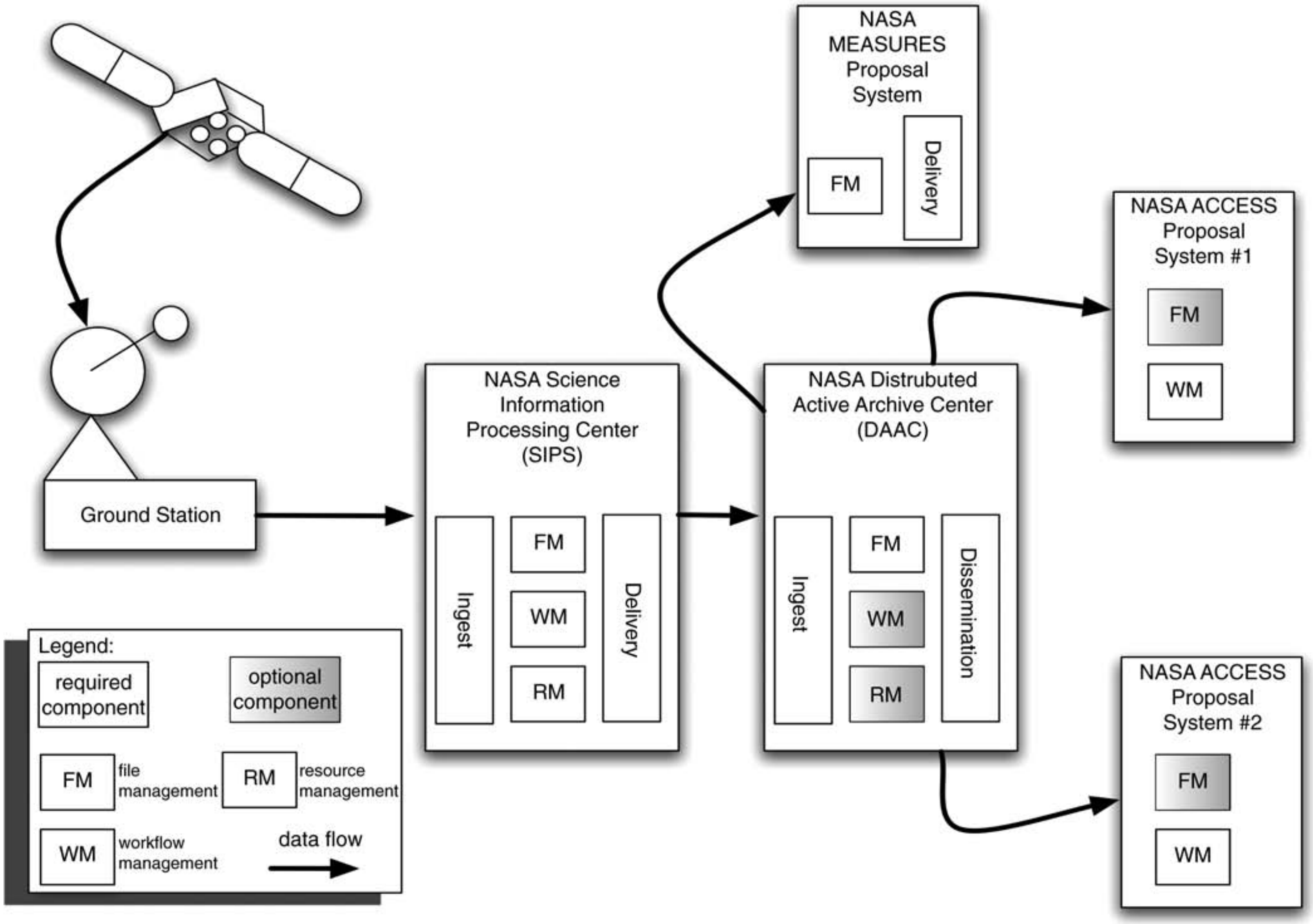

Figure 1. The NASA Earth Science Context. Data is taken by and sent to ground stations, which move the data to SIPS. DAACs are responsible for long-term archiving of the information, and dissemination. Ad-hoc analyses occur in the ACCESS and MEASUREs programs.

have also demonstrated the utility in the reuse of software assets.

However, to date the aforementioned efforts are the exception and not the norm. Many Earth science data system components and architectural patterns are reconstructed for each mission. There have been a number of reasons for this practice including: (1) the distributed scientific expertise of NASA, (2) the desire to have that expertise co-located with the data as it is processed and delivered for wide dissemination, (3) procurement practices, where contract and equipment resources are stove-piped into separate contracts and programs, and (4) each scientific community purports a unique set of requirements for data processing and data products, that may not easily lend itself to justify reuse.

The paradigm of NASA missions is changing, primarily due to the upcoming missions identified in the National Research Council's Earth Science and Applications from Space decadal survey [5] (as well as other future "decadal-like" missions). It is even more imperative that NASA look to reduce costs, increase software productivity, explore areas for consolidation of homogeneous services, and ultimately promote and facilitate a culture of reusing successful software assets and patterns across its missions.

Software reuse can help inform the successful design of future NASA missions in a number of different ways, in particular through: (1) identification and selection of existing, proven Earth science software components (or software components applicable in Earth science data systems) whose reuse saves development costs and time, (2) application of existing architectural styles and patterns [6] that induce specific quality attributes (reliability, scalability, etc.) in the resultant software, and (3) identification of new assets developed for missions which are of broader applicability, and themselves should be disseminated to the community.

Reusable software artifacts are not limited to just code. These assets may include algorithms and models, architectures and design patterns, systems modules and scripts, technical documentation and test results, and use metrics as well as other artifacts produced during the software development life cycle.

Table 1. Summary of Reuse Readiness Levels (RRLs)	
Level	**Summary**
RRL 1	Limited reusability; the software is not recommended for reuse.
RRL 2	Initial reusability; software reuse is not practical.
RRL 3	Basic reusability; the software might be reusable by skilled users at substantial effort, cost, and risk.
RRL 4	Reuse is possible; the software might be reused by most users with some effort, cost, and risk.
RRL 5	Reuse is practical; the software could be reused by most users with reasonable cost and risk.
RRL 6	Software is reusable; the software can be reused by most users although there may be some cost and risk.
RRL 7	Software is highly reusable; the software can be reused by most users with minimum cost and risk.
RRL 8	Demonstrated local reusability; the software has been reused by multiple users.
RRL 9	Demonstrated extensive reusability; the software is being reused by many classes of users over a wide range of systems.

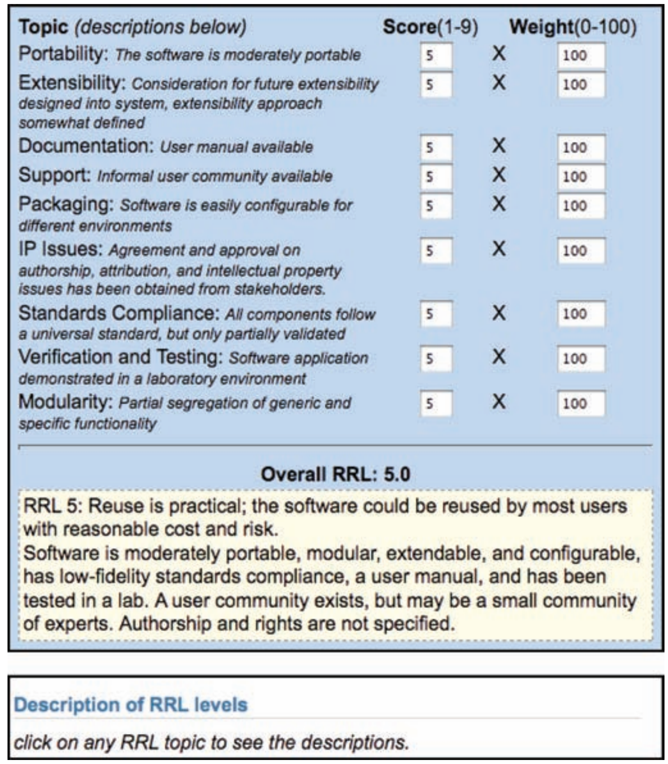

Figure 2. The Reuse Readiness Level Web Calculator. Users input an associated weight and score for each of the RRL topic area levels and an RRL is computed and displayed as a weighted average of those calculations. The associated RRL description is shown in yellow at the bottom of the calculator.

The NASA Earth Science Data Systems (ESDS) Software Reuse Working Group (SRWG) is chartered with the investigation, production, and dissemination of information related to the reuse of NASA Earth science software assets. One major current objective is to engage the NASA decadal missions in areas relevant to software reuse.

In this paper we report on the current status of these activities. First, we provide some background on the SRWG in general and then discuss the group's flagship recommendation, the NASA Reuse Readiness Levels (RRLs). We continue by describing areas in which mission software may be reused in the context of NASA decadal missions. We conclude the paper with pointers to future directions.

II. Working Group Background

The NASA Earth Science Data Systems (ESDS) Software Reuse Working Group is chartered with the promotion and identification of software assets targeted for reuse in NASA's Earth Science Data System pipeline [7]. The group is focused on architectures and technologies that facilitate software reuse. In particular, we are investigating software components and architectures developed to enable cloud and grid computing capabilities, as well as cyber infrastructure for using mission and scientific data.

The flagship product of the group to date is a focused set of NASA Reuse Readiness Levels (RRLs), which have been released and are now available for use [8]. The RRLs, similar to the NASA Technology Readiness Levels (TRLs) for technology, are a nine-level guide that can be used to rank and compute the reusability of a software asset [9]. A summary of the RRLs, taken from [8], is shown in Table 1.

Besides the RRLs, the Software Reuse Working Group (SRWG) is also working on the development of case study documents describing efforts to leverage the RRLs in the assessment of two areas of NASA mission software: (1) the methodology and suitability of existing NASA software assets for inclusion in a mission, and (2) the identification, curation, and dissemination of software assets that are being developed as part of a NASA mission that can be included in future missions. In addition, the SRWG is working on a recommendation for the packaging of reusable software assets to facilitate distribution, covering an information model for software packaging, and a classification/comparison of the state of the art in software packaging techniques.

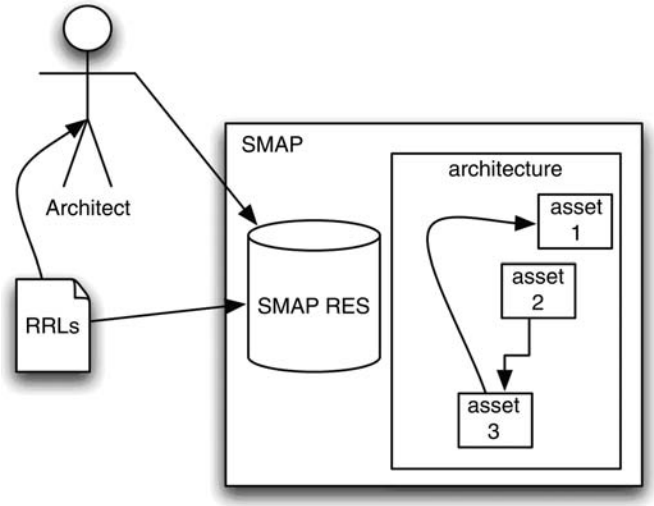

Figure 3. Using the SRWG RRLs and RES to design and implement NASA decadal missions.

Both of the aforementioned documents are considered works-in-progress, and both of the documents include input from current NASA decadal missions, including the Soil Moisture Active & Passive (SMAP) mission and the Ice, Cloud, and land Elevation Satellite 2 (ICESat-2) mission. We also are actively working with other Tier-1 NASA decadal missions including the Orbiting Carbon Observatory-2 mission, and the Deformation, Ecosystem Structure and Dynamics of Ice (DESDynI) mission to best determine how and where reusable software assets could be leveraged. We plan to support the upcoming Tier-2 missions as they begin to ramp up as well. In the next section we will provide greater detail about the NASA Reuse Readiness Levels (RRLs) and their applicability to NASA decadal missions.

III. Reuse Readiness Levels

The NASA Reuse Readiness Levels (RRLs) have been developed for use as a measure to evaluate the potential reusability of software. The RRLs can be used to assess software that is being developed or to assess software assets that are being considered for adoption. Software can be evaluated either by using the RRLs in a simple manner to obtain a rough assessment of the software or by using the RRLs more extensively to obtain a precise assessment, which would include an assessment of the software in terms of nine topic areas.

Using the RRLs in a simple manner, the software under evaluation is compared to the brief summary descriptions of the RRLs to determine a value, from 1 to 9, that reflects the level of the potential reusability of the software. The RRLs can be used in this way to attain a quick assessment, which lacks precision, but may be appropriate for attaining efficient assessments when comparing many competing software candidates or when only a rough estimate of the potential reusability of a software product is required.

Alternatively, extensive use of the RRLs can be applied by using a 9×9 grid to evaluate the software against each of the topic areas to determine the level of maturity that the software has attained for each of the nine topic areas. Using the RRLs in this extensive manner can be more time consuming, but enables assessment of each topic area to identify areas where additional development may be required to meet the needs of a particular software project. Prior to using the RRLs in this manner, the software requirements of the project should be identified for each topic area so that the level of effort necessary to improve the software to an acceptable level for each topic area can be determined.

A calculator is being developed for use with the RRLs (a web-based prototype of this calculator is shown in Fig. 2). Using the RRL calculator, weights can be established for each topic area, depending on the importance of a particular topic area to meet the requirements of a particular software project, and an average overall RRL value can be calculated from assessments of topic area levels. A more advanced version of the RRL calculator, which may offer more features and/or guidance on assessing software assets, is under consideration. The SRWG has also received a copy of a Microsoft Excel-based calculator tool, developed by modifying an existing TRL calculator [10], from a member of the software reuse community. We are examining this tool to ensure that it correctly captures the information contained in the current release of the RRL document.

Tools such as the RRL calculator enable a structured evaluation of reusable assets as software producers and consumers measure applicability and compatibility for their particular project. We are exploring the integration of the RRL calculator with our Reuse Enablement System (RES) [11], a software portal used to track and disseminate information about reusable software assets. The RES system is currently being deployed by the Soil Moisture Active & Passive (SMAP) mission as a proof of concept as shown in Fig. 3. In the following section, we will describe the relationship of RRLs and associated software reuse tools to that of the NASA decadal missions.

IV. Reuse of Mission Software

The reuse of software offers opportunities for the new decadal survey missions and future space missions to reduce costs and improve the quality of the software that is either produced by or used from previous efforts. Likewise, software reuse offers opportunities to obtain similar benefits when processing and reprocessing data obtained from such missions. Recipients of the NASA ESDS Software Reuse Working Group Peer-Recognition Software Reuse Award [12] have demonstrated the contribution of new reusable assets and the utilization of existing reusable assets in systems development for NASA missions; for example, the National Polar-orbiting Operational

Environmental Satellite System Preparatory Project's Science Data Segment reused a variety of system components to reduce development effort and help ensure reliability [13], as did the Orbiting Carbon Observatory's (OCO) Ground Data System [4].

In conjunction with the ICESat-2 mission effort, procedures and templates also are being developed to use the RRLs to assess the current state of readiness when assessing software from previous missions for potential reuse in future missions. Using such tools can help to improve the usability of software created during previous missions. Such tools also can be used to assess the potential reusability of software that is being developed for new missions to improve its potential for reusability in other future missions. The SRWG plans to work with the ICESat-2 team as needed to help them assess some of the existing software assets from the original ICESat mission that they plan to reuse.

In addition, using tools, such as calculators (as shown in Fig. 2), templates, and procedures, in conjunction with the RRLs, to assess the reusability of software, can identify aspects of the RRLs that may be considered for possible improvement. ICESat-2's experience will enable a use case study to help the SRWG improve the RRLs and how they are used to perform software reusability assessments. Likewise, testing the use of such tools for assessing the potential reuse of software also will contribute to their refinement and inspire the development of additional tools for assessing reusability [14–16] and can foster the consumer's confidence that the asset has been assessed as to its level of robustness and readiness for operational use.

V. Conclusions

Considering the data processing needs of the new decadal survey missions, the reuse of software from previous missions offers an opportunity to leverage the investments made in previous missions. The RRLs have been developed by the ESDS SRWG to assess the readiness of software for potential reuse. Using the RRLs in conjunction with other tools, such as the RRL calculator, templates, procedures, and lessons learned, can improve capabilities for reusing software in new missions and for realizing the benefits of software reuse.

In addition to reusing software and system artifacts from previous missions in the new missions, software reuse offers an opportunity for the decadal survey missions to develop software that can be used in other future missions. Planning for the potential reuse of new software can complement the efforts of reusing previously developed software. Adopting a systematic approach to software reuse can contribute to the improvement of software development practices and to the potential reuse of software and other system artifacts in the future [15].

The use of tools to assess the reusability of software and to register and describe software for potential reuse offers benefits for organizations that develop software for potential reuse and for those that reuse existing software. The use of such tools for the decadal survey missions can assist in the preparation of software that was developed for use in previous missions for possible reuse in future missions. In addition, these tools also can help to prepare software that is being developed for the new missions for use in future missions.

Software assets considered as candidates for potential reuse can be registered and described in a RES where they can be found and analyzed by developers for inclusion in future systems. Refining such tools and developing additional tools to support the reuse of software can contribute to the capabilities available for both software producers and software adopters.

It is important for current missions to recognize that the systems and components they are currently developing may have the potential to be reused by future missions. Therefore, any steps they can take to make such assets more reusable will help encourage a more systematic reuse process, one that can continue to improve future missions through the realization of the benefits of software reuse.

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ORGANIZATIONAL PROFILES

BALL AEROSPACE & TECHNOLOGIES CORP.

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Three months after the April 2010 Deepwater Horizon oil platform explosion in the Gulf of Mexico, a team of Ball Aerospace & Technology Corp. scientists and engineers flew above the spill to test a unique suite of sensor instruments. Over the course of two days, they took images of the oil slick marking the uncapped well using a spectrometer, a low-light imager, and a thermal imager. This instrument suite provided airborne data which complements government funded campaigns including additional channels for ultra-violet and long wave infrared signals. Using Ball Aerospace-developed algorithms, the team combined the individual data sets to study the oil extent and characteristics to improve disaster response efforts in the future. The algorithms for radiometric calibration and georectification extract distinguishing spectral features and compute the ground position of each pixel of a sampled area. William (Bill) Good, an engineer at Ball Aerospace and lead for the Airborne Initiative and Heliostat team on the flight, noted, "The UV part of the instrument was specifically designed for ocean color measurements in that band. The spectrometer very accurately measures light levels in the visible spectrum as well as in the UV range as it measures reflected sunlight from the water. You can characterize what is on the water's surface from this instrument, whether it is plant life, oil, or some other material based on what the reflection looks like. Combining the instruments was essential to eliminate false signals though. A single imager has difficulty in culling all the properties of a sample. Together, the individual images can be overlaid and corroborated with satellite and in-situ measurements."

Bill and his team are part of the Civil and Operational Space business unit at Ball Aerospace where they and many other people help make the company a leader in the fields of

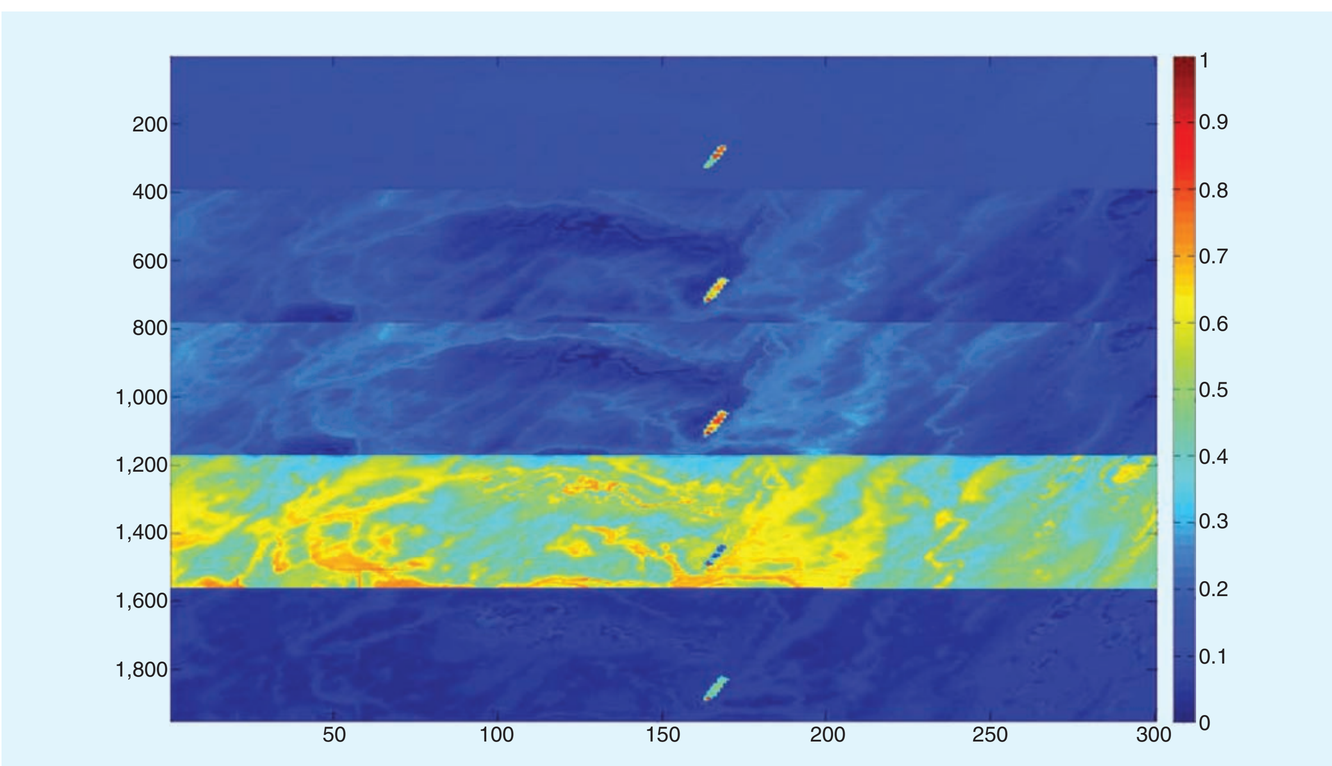


Figure 1. Spectrometer image with combined channels at the top and spectrally decomposed images below showing ratios of various wavelengths optimized to accentuate properties of the oily water surface (note the ship near the center of each image).

remote sensing and Earth observation. The company develops groundbreaking technologies for defense, civil and commercial customers, including full satellite systems and space missions; instruments and sensors; engineering services; antennas, tactical camera systems, and components; as well as a variety of space-qualified subsystems. Ball Aerospace, founded in 1956, is a subsidiary of Ball Corporation, with employees in Colorado, New Mexico, Ohio, Georgia, Virginia, Maryland, and Washington DC.

Facilities

Ball Aerospace has major research, development, and manufacturing facilities located in Boulder, Broomfield, and Westminster, Colorado. These facilities, located within 10 miles of each other northwest of Denver, include all of the resources required for the design, production, and test of state-of-the-art satellites, electro-optical instruments, spacecraft subsystems, cryogenic devices, antennas, and video systems for military, civil and commercial space applications.

Developmental hardware is produced in Ball Aerospace's on-site cleanrooms, production shops, and numerous hardware and software laboratories. The facilities include a computer-aided manufacturing center, a rapid-prototyping capability, and a lubrication laboratory, as well as electronics assembly, encapsulation, machining, cleaning, and flight assembly and inspection areas. Because many of Ball's programs are classified, its facilities also include space for secure data processing and manufacturing.

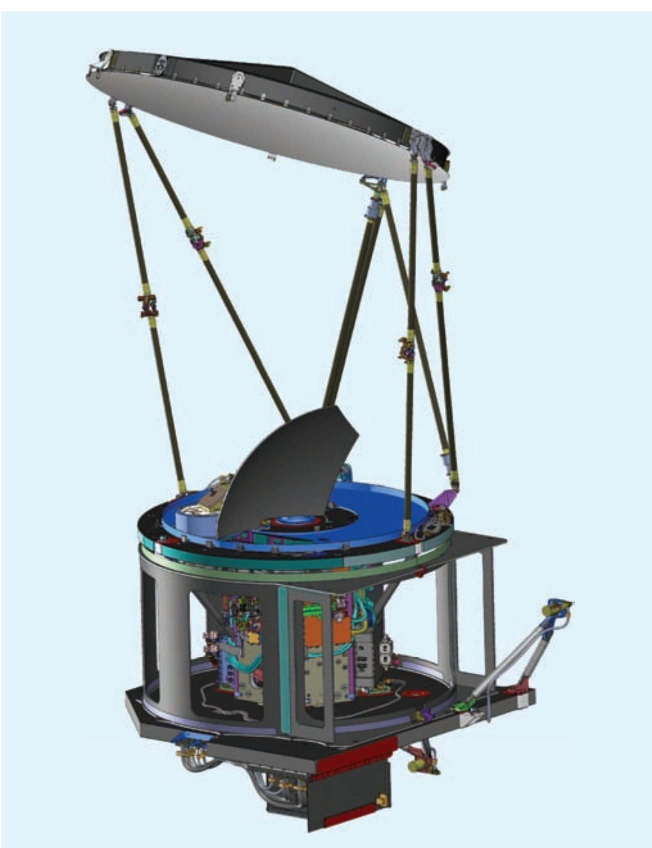


Figure 2. Concept art of GMI (copyright NASA).

In response to its growing business, Ball Aerospace expanded its Boulder, Colorado Fisher Complex spacecraft production facility in 2007; the expansion included 60% more cleanroom space, a second large thermal vacuum chamber, spacecraft assembly and testing capabilities all under one roof. This facility is humidity and temperature controlled and is rated to a cleanliness level of class 100,000. Another large Colorado production facility, the Aerospace Manufacturing Center, was built in 1988 specifically for antenna fabrication, assembly, and test. Foreseeing a steady increase in production and development work, Ball expanded the center in 2008 to provide additional test capabilities, assembly, and secure classified areas. Final completion is expected in 2011.

Electronically Steerable Flash Lidar

The Electronically Steerable Flash Lidar (ESFL) is a new type of imaging, full-waveform lidar for advanced three-dimensional imaging of forest scenes. Designed with a technology path-to-space, it uses independently steerable multiple beams from a laser combined with a two-dimensional "Flash" focal plane array configured with integrated micro-lens arrays. The combination allows the system to be dynamically reconfigured to match the spatial sampling to the forest scene of interest to maximize science return. The ESFL combination of a unique transmitter and a unique receiver where the laser transmitter is built around a crystal optic beam deflector that takes an input laser beam, and depending on the number of frequencies or commands given, will split the input beam into that same number of output beams. An operator can control the number of beams and their positions on the ground.

The ability to reconfigure the beam pattern while imaging the patterns has a number of advantages. Larger beams can be used to match typical tree crown sizes for a region while simultaneously sub-beam imaging can provide finer detail. The beams can be configured for contiguous sampling as a pushbroom to measure the fine spatial scales of the forest (important for estimates of biodiversity) or spaced apart to give a statistical measurement of the biomass stored in the larger forest. The fine pointing capability can allow precise beam ground tracks to be followed from aircraft or space. Using data from co-boresighted secondary cameras, the beam steering can be used to steer the beams to fall between clouds (when broken), increasing science returns. Since a two-dimensional Flash focal plane array is used, the beams can be configured as either cross-track, along-track, or even a combination where the beam energy can be re-configured at the video rate of the focal plane.

Ball Aerospace completed its development and demonstration of the ESFL system in late 2010. Dr. Carl Weimer, the ESFL Primary Investigator at Ball, conceived of the idea after attending a conference where he listened to scientists lament the lack of options available for a future forest sampling mission. Weimer considered what the scientists were trying to do and came up with the beam-splitting idea as a possible solution. The program is starting to realize some of its promise as Ball recently garnered a $1.5 million NASA Airborne Instrument Technology Transition study titled "Advanced Imaging Lidar for Forest Carbon Studies." The study will extend the performance capabilities of the ESFL system and prepare it for future investigator-led aircraft science campaigns. This study includes aircraft demonstration work validating its science measurements using traditional forest survey methods, new close-range photogrammetry, and a ground-based lidar.

Dr. Tanya Ramond, Ball's Deputy PI for the ESFL program, explained one of its potential benefits—a significant savings in time, "How efficiently you use the photons is key to a laser observation mission. What ESFL offers is the ability to steer around potential objects of no interest, but also vary the sampling configuration for the beam at hand. You can maximize the use of your laser power and time. Our studies suggest that ESFL can achieve the same result in one-third of the time that is needed when using transect sampling."

Global Precipitation Measurement-Microwave Imager

Ball Aerospace's Global Precipitation Measurement-Microwave Imager (GMI), a multi-channel, conical-scanning, microwave radiometer, will play an essential role in the Earth's weather and environmental forecasting. As a central part of the Global Precipitation Measurement (GPM) mission, GMI allows for a greater temporal sampling of rainfall accumulations as well as more frequent and higher quality data collection than what is available currently with the Tropical Rainfall Measuring Mission (TRMM).

Indeed the GMI is the next generation of large passive reflector radiometers available to NASA with improvements in sensitivity, footprint, calibration, and resolution. Don Figgins, the GMI program manager at Ball, said, "The frequency range of GMI is unique. Where TRMM doesn't have a frequency above 35 GHz, we've added high-frequency channels to where the radiometer will operate at select frequencies ranging from 10.65 to 183.3 GHz. So instead of only collecting rain data from a tropical environment, now we're going to continue that and also be able to get a new set of snow and ice crystal precipitation data for scientists to evaluate." This is a major contribution to precipitation measurement over the entire globe and a new capability available to scientists. Dr. David Newell, the program's Chief Systems Engineer at Ball explained, "There is a good capability of precipitation measurement over land from ground based radars, however there isn't much capability for measurements over water masses. Rainfall over the ocean is a primary driver in a lot of the weather models currently used. So when there is a big weather front out over the Pacific, how much energy is gained and lost from the front over the ocean can be determined with an instrument like GMI and this is a major factor in determining the accuracy of the long term weather forecasting."

While TRMM showed that comprehensible precipitation data can be gathered from low-earth orbit, the satellite's path only ranges from about 20 degrees north and 20 degrees south from the equator, which is localized right around the rainforests. Scientists know where and when it rains in the populated, land areas of the world, but 70 percent of the earth is covered by water and scientists aren't cognizant of how much it rains where there aren't people. Figgens noted that GMI will increase the ability to observe more of the globe. "GMI will be a more global mission, as it will follow a sinusoidal orbit within 65 degrees north and 65 degrees south latitude from the equator, in essence from southern Canada to northern South America. We will still get the data from the tropical latitudes, but as the GMI completes a 3-hour orbit we will get continuous data from a greater range."

GMI will play a role in radiometric coverage of the Earth's polar regions. Right now there are polar-orbiting radiometers to measure the precipitation at those areas and their orbits will allow them to cross periodically with the GMI instrument and that provides a way to get an increase in time refresh for weather model accuracy. However, combining the data from different instruments presents a potential problem in accuracy. GMI is designed to be the standard in calibration, that is it has to be the most stable and have the lowest level of uncertainty, or else whatever errors exist may be transferred to other measurements. A stable calibration and cross-calibration with other instruments measuring the same parameter allows long term trending data as they fly over the same area.

Ball developed certain design features for the instrument to improve and track the calibration on orbit, something that will influence the subsequent radiometer designs and will improve the accuracy of returned data. Every radiometer uses a hot load and cold sky target as reference points for instrument calibration. The hot load maintains a constant temperature between roughly 140 and 200 degrees Kelvin while the cold sky target looks out to deep space. However, these only provide two points of reference and each can have temperature variance from other sources. Ball's calibration approach uses a technique that introduces a set temperature somewhere between the hot and cold loads that provides a third point of reference. With three independent points of calibration points to check against each other, independent calibration verification can be conducted on the instrument. Previously, one had to look at the returned data on the ground to see if there was

Figure 3. The Operational Land Imager in Ball Aerospace's Stray Light Test Facility.

any calibration drift, but scientists should be able to verify calibration directly on the GMI instrument.

Once the GMI is completed, it will be matched on the GPM spacecraft with radar instruments to accurately measure, via reflectivity and estimates of attenuation, the vertical profiles of the clouds and precipitation, including drop size distribution. With this combination there is greater accuracy available than what could be gained from each separately. In some places a radiometer works best, in others a radar is better, but the two combined will give the best results. Even though the GPM satellite hasn't flown yet, interest in what data the mission could provide has spurred the development of an additional satellite—with an identical copy of Ball Aerospace's microwave radiometer instrument installed—which will provide near-global scanning of the Earth so that valuable data can be collected. While the first GPM satellite consists of a core spacecraft operating in mid-latitude bands and scanning the areas in a low-Earth orbit, where most of the Earth's liquid water is found. The second satellite will be a part of a constellation of satellites that operates in a polar orbit, collecting data around the Earth's polar caps.

Operational Land Imager

Ball Aerospace has a strong legacy in both Earth observation and remote sensing missions, including WorldView-1 and WorldView-2, QuickBird, Radarsat, and QuikSCAT. One of Ball's current remote sensing mission programs is to design, develop, fabricate and integrate the Operational Land Imager (OLI) for the eighth Landsat Data Continuity Mission (LDCM). It is slated to launch in late 2012 and is expected to be on orbit for at least five years.

The Landsat Program is a series of Earth-observing satellite missions jointly managed by the U.S. Geological Survey and NASA. For more than 30 years, the Landsat missions have gathered multispectral imagery that has provided continuous land surface observations. Scientists use the data to monitor changes in global land cover; manage the Earth's natural resources; make decisions about land-use planning; and understand ecosystem dynamics. The OLI instrument provides 15 m (490 ft.) panchro-matic and 30 m multi-spectral Earth-imaging spatial resolution capability. The imager includes a 185 km swath allowing the entire globe to be imaged every 16 days.

To help continue USGS's longest continuous imagery data record of our planet, Ball Aerospace is leveraging its experience with detectors to produce the focal plane subsystem. OLI has a focal plane array of 14 state-of-the-art arrays and operates in a pushbroom fashion – taking images as it looks at a spot on the Earth's surface then continuing forward, unlike older Landsat telescopes that scan a smaller field-of-view back and forth. Ed Knight, the program's Lead Systems Engineer, said, "This is a multi-module focal plane and it doesn't use charge coupled devices like Ball's Kepler telescope but rather photo diode arrays. The thing that allows Ball to lay out a very wide field using 60,000 detectors and be able to align them perfectly to get images without creating a monstrous-sized telescope is our optical design that has a small calibration source. Our calibration and characterization of the Ball Aerospace heliostat ground calibration facility is unique in the industry. Honestly, OLI is one of the first generation high-quality pushbroom imagers and it is clear that its design approach will continue with later imagers."

The OLI design is good example of where engineering and science meet. There are high resolution imagers like the WorldView instruments, that don't have a very wide swath. On the other end of the imaging spectrum there are instruments with a wide swath but low resolution. The OLI nestles in between those two extremes and its design is a function of what science requires. Knight explained, "You really have to get into [it] to understand the engineering quirks and the science it's being used for to understand the calibration and characterization. You really need to understand what science actually occurs in the instrument design."

Ball Aerospace is at the forefront of bringing a group of operational and near-operational instruments with never-before-seen capabilities to the remote sensing community. Work like this not only requires a high degree of engineering and scientific expertise but also a deep commitment to the environmental information needs of scientists, governments, and people around the globe. With more world-wide interest in the Earth's climate than ever before, Ball Aerospace has the means to lead in the transition toward repeatable, Earth-observation programs that best meet the requirements and budgets of future scientific inquiry and weather and environmental monitoring.

REPORTS

IGARSS 2010 SURVEY: MEMBERS AND ATTENDEES RESPOND

John Kerekes, Rochester Institute of Technology, Rochester, NY, USA
Chair, IEEE GRSS Conference Advisory Committee

Introduction

The International Geoscience and Remote Sensing Symposium (IGARSS) is the premier conference organized by the Geoscience and Remote Sensing Society (GRSS). It is the annual gathering place for researchers and practitioners of remote sensing and is held in different international locations each year. IGARSS'10, held in Honolulu, Hawaii, USA, was the 30th anniversary of the event and attracted nearly 2000 participants.

To better understand the interests and preferences regarding IGARSS, the Conference Advisory Committee of the GRSS Administrative Committee (AdCom) recently conducted a web-based survey among GRSS members and IGARSS'10 attendees solicited through an e-mail invitation. A total of 1121 responses were received, of which 290 provided open-ended text comments. The survey consisted of 15 multiple choice questions. This article provides a summary of the findings.

Respondent Demographics

The majority responding to the survey were members of both IEEE and GRSS, while approximately one quarter were not a member of either. The largest geographical area represented was North America, followed by nearly equal numbers in Western Europe and Asia (including Australia and New Zealand). The remaining respondents were divided between Eastern Europe, Africa, and South America.

Most were working professionals, while about one-fifth were students and a few percent retired. Most were affiliated with an academic institution, with the rest working for the government, the private sector, or a non-profit organization.

Reasons for Attendance

In response to the question of "What is your primary reason for attending IGARSS?" the highest percentage cited the "technical content of the sessions." Significant numbers cited "to share work with others and obtain a publication" and "networking". A few percent said they attend for the tutorials and workshops, while one out of ten said they do not generally attend.

Peer Review of Proceedings

One of the motivating reasons for the survey was to gauge interest in moving from the IGARSS tradition of optional, non-peer reviewed proceedings papers to a full peer-review process for paper selection and program placement. The results suggest a dichotomy of perspectives on this topic. The majority preferred continuing the current model, although a significant number would like to see the conference move to a full peer review process.

This split reflects the diversity of reasons for participating in the conference and suggests that such a change is not warranted at this time.

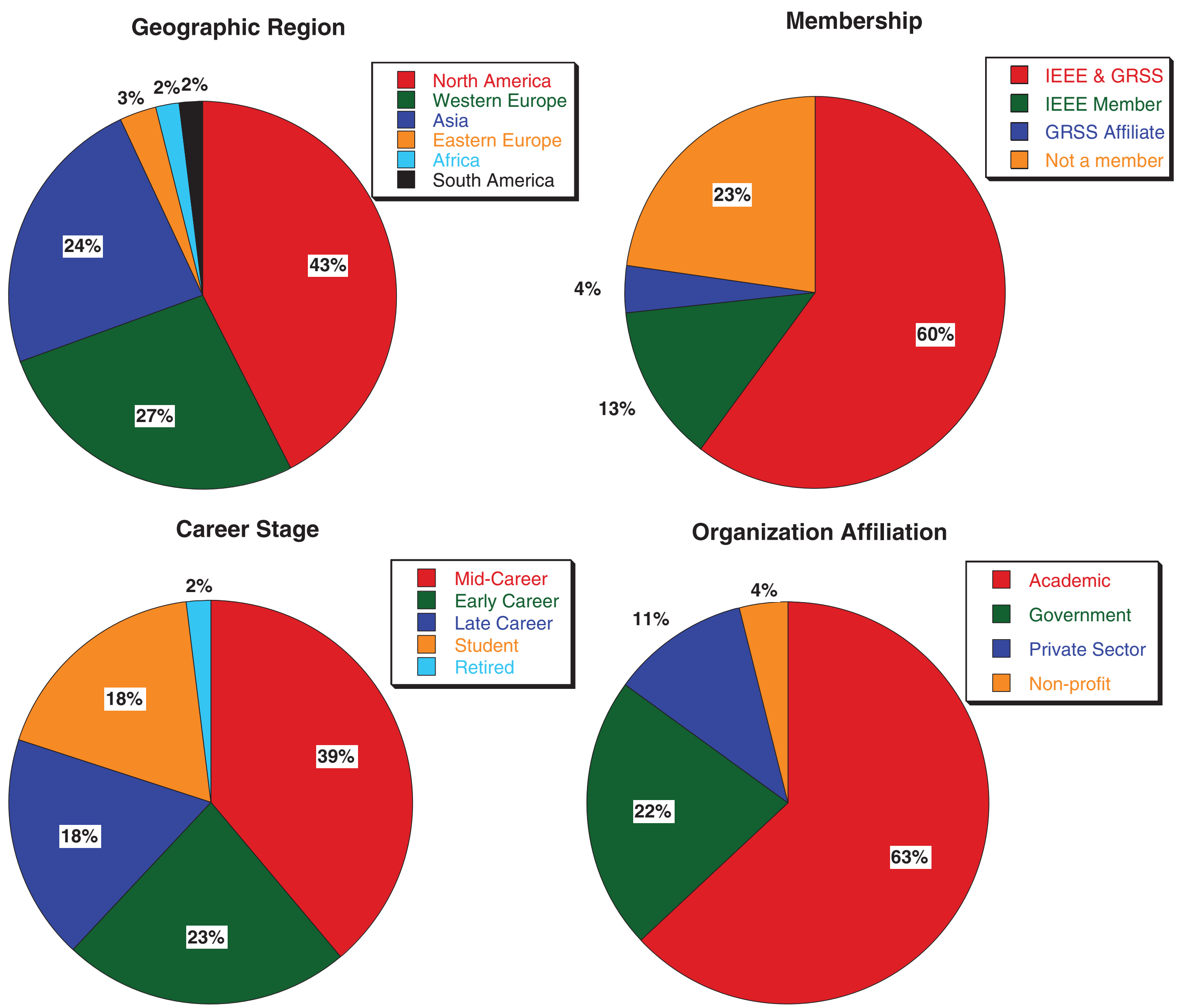
Balance of Invited and Contributed Sessions

Another significant question in the survey related to the balance of sessions formed by unsolicited contributed papers and those formed by invitation. An overwhelming majority (87%) felt the invited papers should be less than 30% of the total accepted, with the remaining fraction (13%) preferred allowing up to 50% invited papers. This result suggests participants prefer an open process with the best papers being selected for the conference, while still appreciating the value of special topic invited sessions.

Posters, Conference Venue and Tours

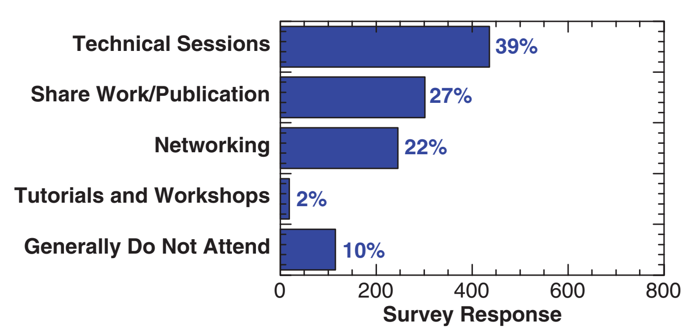
A set of questions addressed logistical aspects of IGARSS. A clear majority (62%) expressed a preference for dedicated poster sessions that do not overlap with oral sessions, with a modest fraction (21%) preferring the format used in IGARSS'10 (overlapping oral and poster sessions). 9% selected the option for day-long sessions with no required time for authors to be present and 8% expressed no opinion. The format used in Honolulu was due in part to venue constraints and likely will not continue for future IGARSS.

Regarding the venue, there was no strong preference expressed among the options presented: 34% preferred a hotel with easy access between sessions and rooms; 29% preferred a university campus with lower cost; 25% preferred a convention center; and 12% expressed no opinion.



Respondent Demographics.

As far as interest in local tours arranged through the conference, most (57%) expressed interest in participating, with 31% expressing no interest and 12% with no opinion.

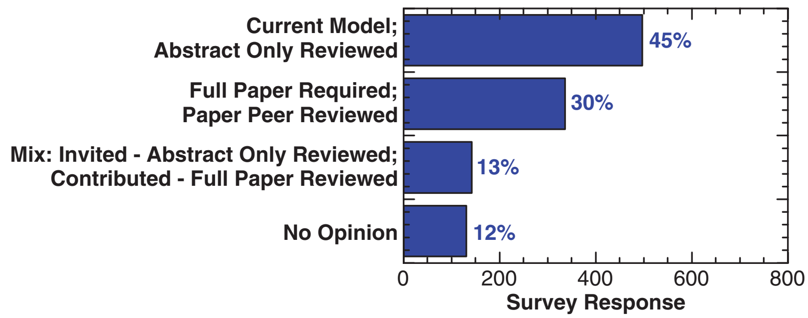


Attendance Reasons.

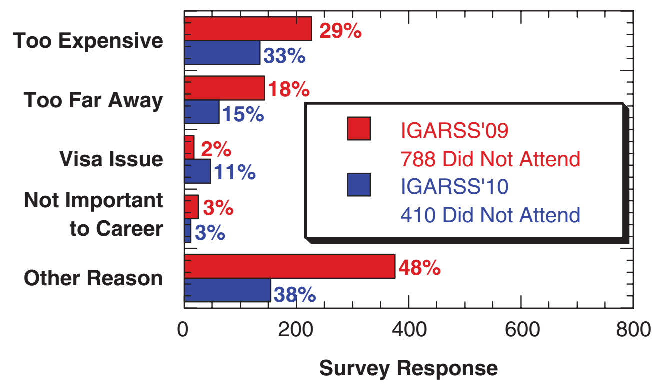
IGARSS'09 and '10 Experiences

Four questions addressed specifics related to the two most recent IGARSS. Regarding IGARSS'09 in Cape Town, only 26% of respondents indicated they had attended. Of those not attending, the most cited reasons were too expensive and too far away, although the majority selected "other" as the reason. Of those who did attend, over 70% rated the technical program as excellent or good, with just 6% saying it needs improvement. Regarding the Plenary, over 75% of those saying they attended the conference reported attending the Plenary with the majority of this group (71%) saying "it served its purpose", 16% saying it was a "highlight of the conference", and just 13% responding they "did not find it useful". Of those attending the workshops and tutorials, over 90% rated them as excellent or good.

Concerning IGARSS'10 in Honolulu, 63% of the respondents indicated they attended. The reasons for not attending were similar to the responses for IGARSS'09, except that more cited issues of obtaining a visa to USA. Of those who did attend, 78% rated the technical program as excellent or good, with just 6% saying it needs improvement. Regarding the Plenary, over 75% of those saying they attended the conference reported attending the Plenary with the majority of this group (66%) saying "it served its purpose", 21% saying it was a "highlight of the conference", and just 13% responding they "did not find it useful". Of those attending the workshops and tutorials, over 93% rated them as excellent or good.



Peer Review of Proceedings Papers.



Reasons for not attending recent IGARSS.

Attendance Plans for IGARSS'11

The final question addressed plans for attending IGARSS'11 in Sendai, Japan. A majority of respondents (54%) indicated they do plan to attend. The most common reason (44%) for not planning to attend was "will not be able to secure travel funds." Equal numbers (26%) cited "too far away" or "other reason," while only 4% of those respondents not planning to attend selected "not important for professional career."

Open-Ended Comments

Nearly 300 respondents provided additional comments. These were reviewed and grouped into categories. The most common comments were very positive about IGARSS. The rest were either critical in nature or offered suggestions for improvements. Many commented that IGARSS is too expensive, and there were many comments critical of specifics at IGARSS'10 (limited Wi-Fi, limited discussion seating, poster sessions being too short and overlapping oral sessions, and the venue being too big, confusing, and expensive). Additional critical comments cited poor quality papers and too much overlap in simultaneous parallel sessions. There also were many comments expressing a strong preference for IGARSS to be a venue for the presentation and publication of timely results.

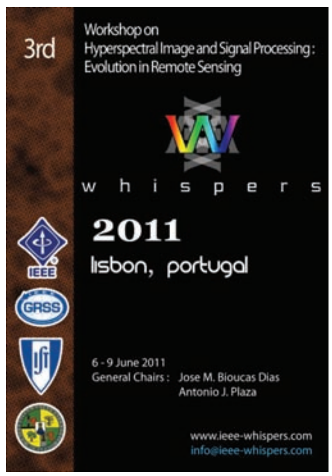
Summary

Based on these results, IGARSS continues to well serve the diverse interests and preferences of GRSS members and conference attendees. While there were some critical comments, the recent event in Honolulu had all time record numbers of abstract submissions and attendees. Nonetheless, the AdCom and organizers of future IGARSS will carefully consider these survey results and continually seek to improve the conference technical quality and experience for attendees. Thanks to everyone who participated in the survey.

WHISPERS 2010

2ND WORKSHOP ON HYPERSPECTRAL IMAGE AND SIGNAL PROCESSING – EVOLUTION IN REMOTE SENSING

Jón Atli Benediktsson, University of Iceland, Reykjavik, Iceland
Jocelyn Chanussot, Grenoble Institute of Technology, France
Björn Waske, University of Bonn, Germany
http://www.ieee-whispers.com



The Second Workshop on Hyperspectral Image and Signal Processing – Evolution in Remote Sensing (WHISPERS) was held at the campus of the University of Iceland, Reykjavik, Iceland June 14–16, 2010. WHISPERS 2010 received the technical sponsorship of the IEEE Geoscience and Remote Sensing Society (GRSS) and financial sponsorships from the University of Iceland and the IEEE Iceland Section. Organized in two parallel tracks over three days, the workshop was a great success, gathering 160 researchers from 30 different countries worldwide.

A total of 161 papers were submitted to WHISPERS 2010 (both regular submissions and special session submissions), 140 of which were accepted, corresponding to a 13% rejection rate. Ninety oral presentations organized in 18 sessions were given at the workshop, and 50 posters organized in 6 sessions were presented in interactive sessions. The evaluation of all the papers was performed based on the reports of anonymous reviewers. On average, each paper received 2.5 reviews. All the papers published at WHISPERS 2010 are available on IEEE Xplore.

The technical program also featured three outstanding plenary talks delivered by three prestigious and highly recognized experts:

- Dr Alan Schaum, from the Naval Research Laboratory, USA, delivered a talk entitled the "Continuum Fusion, a new Theory of Inference."
- Dr Xiuping Jia, from the School of Engineering and Information Technology University College, The University of New South Wales, Australian Defence Force Academy, Australia, delivered the talk "Feature Mining from a Hyperspectral Data Cube for Information Mapping: 3D and Beyond."
- Dr David G. Goodenough, from the Department of Computer Science, University of Victoria, Canada, delivered the talk "Hyperspectral Applications for Forestry."

Three papers were selected to receive a Best Paper Award. The authors received one copy of the greatly sought-after "golden whispers" trophy, and a certificate of recognition during a memorable banquet. Congratulations go to:

- Gabriele Moser and Sebastiano B. Serpico for their outstanding contribution "A Markovian Generalization of Support Vector Machines for Contextual Supervised Classification of Hyperspectral Images"
- Joel Kuusk and Andres Kuusk for their outstanding contribution "Autonomous Lightweight Airborne Spectrometers for Ground Reflectance Measurements"
- Iryna Danilina, Alan R. Gillespie, Matthew Smith, Lee Balick and Elsa Abbott for their outstanding contribution "Thermal Infrared Radiosity and Heat Diffusion Model Verification and Validation".

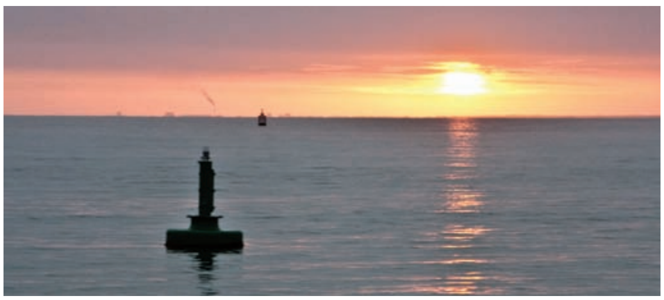
The aim of the WHISPERS workshop is to bring together all the people involved in spectroscopy and hyperspectral data processing, generally speaking.

By "*data*", we mean: **signals**, as provided by spectrometers and processed individually, **images**, from the ground using microscopes and spectrometers to airborne or satellite sensors, up to astrophysical data and **models**: models of the sensors or of the sensed scene, including physical considerations.

By "*processing*", we mean everything from the acquisition, the calibration to the analysis. People were invited to submit

The banquet was held on the Island of Videy.

WHISPERS gathered around 160 attendees from 30 different countries worldwide.



Midnight sun as enjoyed on the ferry back from the banquet.

Our warmest thanks to our three prestigious plenary speakers, Alan Schaum, Xiuping Jia and David Goodenough.

new research results on the following suggested topics: spectrometers and hyperspectral sensors (design and calibration), physical modeling, physical analysis, noise estimation and reduction, dimension reduction, unmixing, source separation, endmember extraction, segmentation, classification, high performance computing and compression.

Applications oriented papers were also welcome. As a matter of fact, spectrometry is now used in a wide range of domains, including: airborne and satellite remote sensing, monitoring of the environment, pollution, precision agriculture, chemistry, biomedical imagery, defense application, industrial inspection, food safety, astrophysics

WHISPERS is also a place for cross-fertilization between **industrial partners** and researchers from the academic world. We would like to thank the companies exhibiting their latest products during the event (Specim, NEO, Itres, and Headwall Photonics) or sponsoring the conference (SpecTir, HyVista and SSI). They are the leaders in the field and we were very happy to welcome them in Reykjavik.

Beyond the technical program, whose quality was highly appreciated by all the attendees, the workshop included some nice social events, including an icebreaker reception and a banquet on the island of Videy. After a memorable and joyful evening, the participants could enjoy a very scenic midnight sun on the ferry back to Reykjavik.

Reykjavik is the capital of Iceland and the northern-most capital city in the world, it was founded in 1786. The Reykjavik Capital Area has just under 200,000 inhabitants, about 60% of the total Icelandic population of 300,000. Visitors to Reykjavik experience easily the pure energy at the heart of Iceland's capital city whether from the boiling thermal energy underground, the natural green energy within the city and around it, or the lively culture and fun-filled nightlife. Many attendees took some extra time to explore other parts of Iceland, including a trip the world famous Geysir.

We would like to thank the members of the program committee for their detailed reviews, which enabled a careful selection, ensuring a high quality workshop. We would also like to thank the organizers of the special sessions: They gathered outstanding contributions. Finally, we would like to thank everyone from the local organizing committee. It has been a wonderful experience working with a great team.

Starting a new series of successful conferences is a very exciting moment. After fruitful WHISPERS meetings in Grenoble, France (2009) and Reykjavik, Iceland (2010), we are very happy to announce that the 2011 WHISPERS will be held in Lisbon, Portugal, June 2011 and hosted by Profs. Jose Bioucas Dias and Antonio Plaza. The usual policy will be used: submission of full 4-pages papers and anonymous peer-review to ensure the optimal quality of the technical contributions.

See you in Lisbon, Portugal, in June 2011 for the GRSS premier event in the hyperspectral world!

WHISPERS is also a place for cross-fertilization between industrial partners and researchers from the academic world. We would like to thank the industrial exhibitors and sponsors who support the conference.

TECHNICAL COMMITTEES CORNER

REPORT ON THE DATA FUSION TECHNICAL COMMITTEE

Jocelyn Chanussot, GIPSA-Lab, Grenoble Institute of Technology, France
Jenny Du, Mississippi State University, USA

The Data Fusion Technical Committee (DFTC) serves as a global, multidisciplinary, network for geospatial data fusion, connecting people and resources. It aims at educating students and professionals, and at promoting best practices in data fusion applications. The committee has about 100 members, and the current Chair and Co-Chair are Jocelyn Chanussot and Jenny Du. A new Chair will be elected in 2011.

The DFTC has two main activities:

- The first one is the organization of a special session held annually during the IGARSS meeting, gathering cutting edge contributions and covering various issues related to data fusion, such as: pan sharpening, decision fusion, multimodal data fusion, data assimilation, multi-temporal data analysis, ensemble methods etc [4].
- The second one is the organization of a scientific challenge. The DFTC contest is held annually since 2006. It is a contest open not only to DFTC members, but to everyone. The aim of contest is to check existing methodologies at the research or operational level to solve remote sensing problems using data from different sensors.

For the 2006 contest, the focus of the contest was set on the **fusion of multispectral and panchromatic images** (pansharpening). Six Pleiades simulated images have been provided by CNES, the French National Space Agency. Each data set includes a very high panchromatic image (80 cm resolution) with corresponding multi-spectral images (3.2 m resolution). An airborne multispectral very high resolution image was available as a ground truth. It has not been distributed to the participants but was used by the organizing committee for the evaluation of the results. The results are reported in [1].

In 2007 the contest main theme was **urban mapping using radar and optical data.** A set of satellite radar and optical images (9 ERS amplitude data sets and 2 Landsat multi-spectral images) were available. The task was to obtain a classified map as accurate as possible with respect to a ground truth data, depicting land cover and land use classes for the urban area under test. The results are reported in [2].

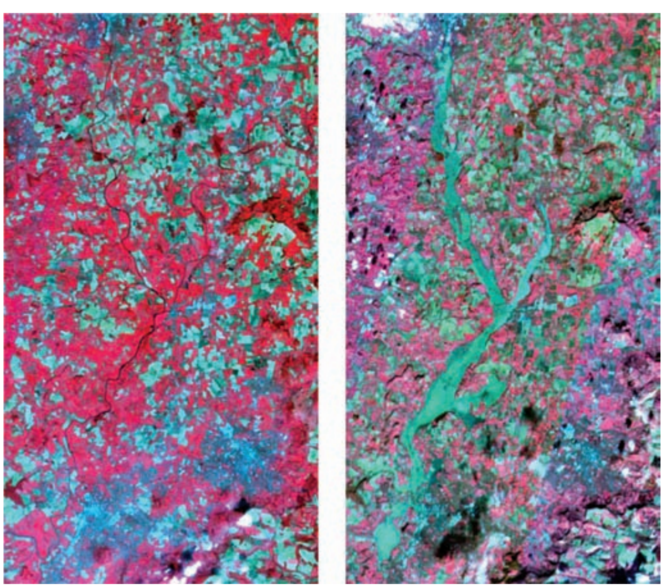


Figure 1. False color composite of the SPOT images before (left) and after (right) the flood.

Figure 2. Change map obtained fusing the best 5 individual maps.

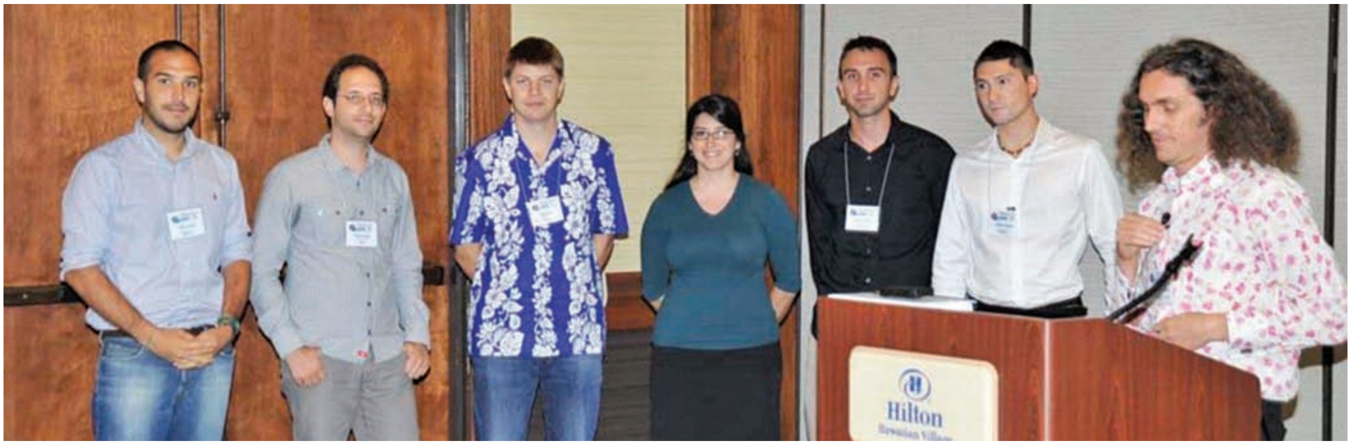


Figure 3. During the Chapters and Technical Committees Luncheon in Honolulu during IGARSS 2010, Jocelyn Chanussot (right) congratulates the winners of the 2009 contest. From left to right: Michele Volpi, Julien Michel, Emmanuel Christophe, Alina Zare, Taylor Glenn and Fabio Pacifici.

In 2008, the contest was dedicated to the **classification of very high-resolution hyper-spectral data**. A hyper-spectral data set was distributed to every participant, and the task was to obtain a classified map as accurate as possible with respect to the ground truth data, depicting land-cover and land-use classes. The ground truth was kept secret, but training pixels could be selected by the participants by photo-interpretation in order to apply supervised methods. The data set consisted of airborne data from the Reflective Optics System Imaging Spectrometer (ROSIS-03) optical sensor. The flight over the

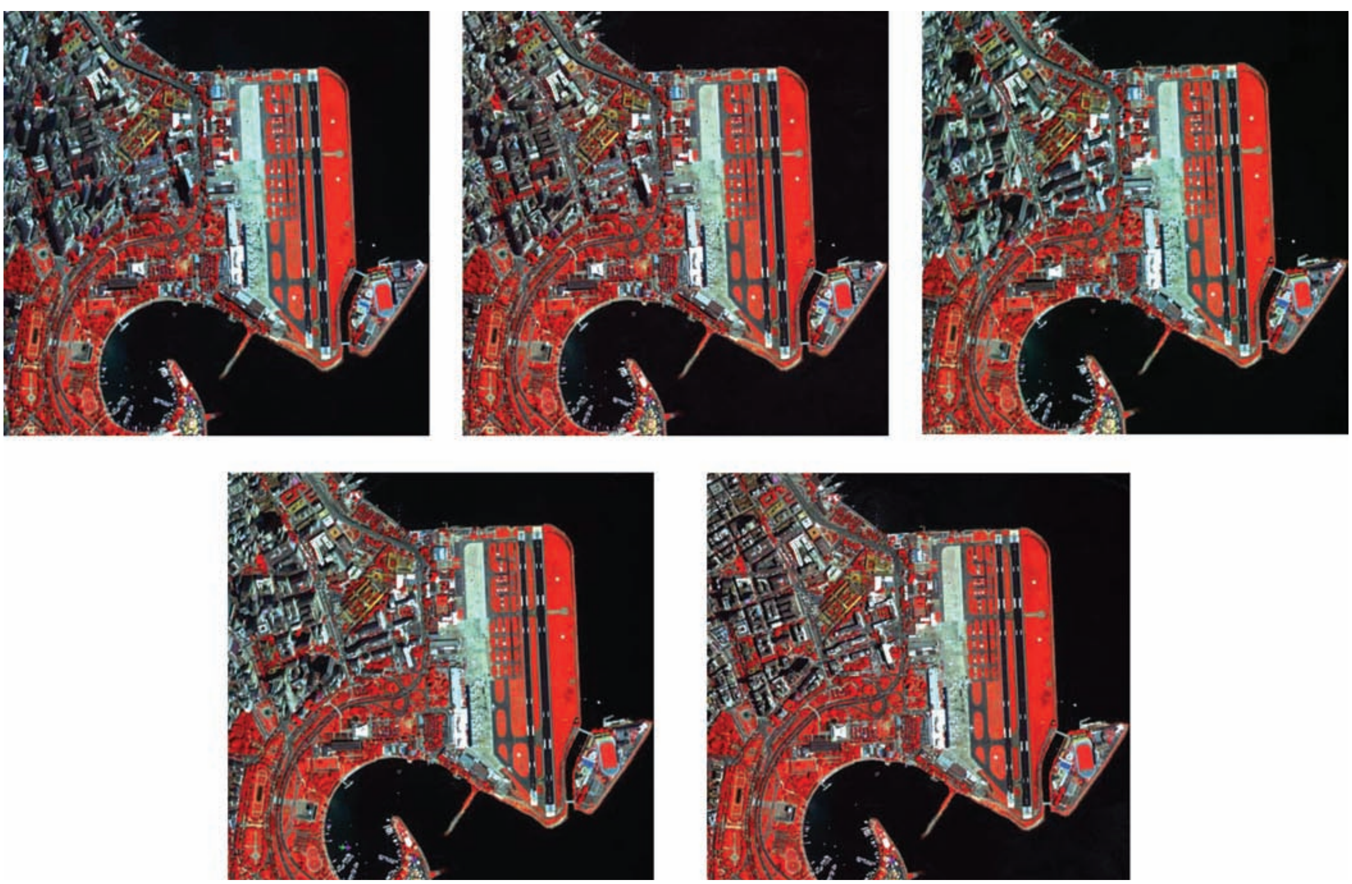


Figure 4. False color composite of the 5 different angular acquisitions of WV2.

city of Pavia, Italy, was operated by the Deutschen Zentrum fur Luft-und Raumfahrt (the German Aerospace Agency) in the framework of the Hy-Sens project, managed and sponsored by the European Union. The number of bands of the ROSIS-03 sensor is 115 with a spectral coverage ranging from 0.43 to 0.86 μm. Thirteen noisy bands have been removed. The dimension of the distributed data set is hence 102. The spatial resolution is 1.3 m per pixel. For the contest, five classes of interest were considered, namely, buildings, roads, shadows, vegetation, and water. The contest was open for three months. At the end of the contest, the participant teams had uploaded over 2100 classification maps. The five best individual classification maps have been fused together. The final corresponding teams have been awarded with an IEEE Certificate of Recognition during the Chapters and Technical Committees' Dinner at the IEEE International Geoscience and Remote sensing Symposium in Boston in July 2008. The results are reported in [3].

In 2009, for the 4th issue of the Data Fusion Contest, the aim was to perform **change detection** using multitemporal and multimodal data. Two pairs of data sets were available for the same scene (the region of Gloucester, UK). This region was flooded and the change detection algorithm should detect the flooded areas. The image data set contains

- two 3 bands SPOT images (one before and one after)
- ERS images (one before and one after)

The pictures correspond to the region of Gloucester UK. Between the "before" and the "after" data, a flooding has occurred: this was the change to be detected (class "change" = flooded area, class "no change" = standard river + areas staying dry). All the pictures have been co-registered. The optical and radar imagery were provided by CNES. Figure 1 presents a false color composite of the SPOT images before (left) and after (right) the flood. The ground truth used to compute the results accuracy has been build by visual expert interpretation and was not provided to the participants. Singular results were tested and ranked a first time using the K coefficient. Then, the best 5 results were used to perform information fusion using majority voting, and re-ranking was provided after evaluating which result most improves the information fusion results with respect to the above mentioned K coefficient. Figure 2 presents the change map obtained after fusing the best 5 individual maps. The winners are presented on figure 3: Michele Volpi, Julien Michel, Emmanuel Christophe, Alina Zare, Taylor Glenn and Fabio Pacifici. Congratulations!

2011 Contest

This year, the Data Fusion Contest aims at exploiting multi-angular acquisitions over the same target area. Since there are a large variety of possible applications, each participant can decide the research topic to work with. A set of WorldView-2 multi-sequence images has been provided by DigitalGlobe. This unique data set is composed of five Ortho Ready Standard WorldView-2 (WV2) multi-angular acquisitions, including both 16 bit panchromatic and multispectral 8-band images.

The imagery was collected over Rio de Janeiro (Brazil) in January 2010 within a three minute time frame. The multi-angular sequence contains the downtown area of Rio, including a number of large buildings, commercial and industrial structures, the airport and a mixture of community parks and private housing. Figure 4 presents false color composite of the 5 different angular acquisitions of WV2.

Please, learn more and join the contest at the following address: http://dgl.us.neolane.net/res/dgl/survey/IEEE_DigitalGlobe.jsp

Looking forward to meeting you at IGARSS in Sendai, Japan, in august for the outcome of this year's contest and for a very interesting special session!

References

[1] L. Alparone, L. Wald, J. Chanussot, C. Thomas, P. Gamba & L.M. Bruce, Comparison of Pansharpening Algorithms: Outcome of the 2006 GRSS Data Fusion Contest, IEEE Transactions on Geoscience and Remote Sensing – vol. 45, n. 10, pp. 3012–3021, 2007.

[2] F. Pacifici, F. Del Frate, W. J. Emery, P. Gamba & J. Chanussot, Urban mapping using coarse SAR and optical data: outcome of the 2007 GRSS data fusion contest, IEEE Geoscience and Remote Sensing Letters – vol. 5, n. 3, pp. 331–335, 2008.

[3] G. Licciardi, F. Pacifici, D. Tuia, S. Prasad, T. West, F. Giacco, Ch. Thiel, J. Inglada, E. Christophe, J. Chanussot and P. Gamba, Decision fusion for the classification of hyperspectral data: Outcome of the 2008 GRSS Data Fusion Contest, IEEE Transactions on Geoscience and Remote Sensing – vol. 47, n. 11, pp. 3857–3865, 2009.

[4] P. Gamba & J. Chanussot, Foreword to the special issue on data fusion, IEEE Transactions on Geoscience and Remote Sensing – vol. 46, n. 5, pp. 1283–1288, 2008.

CHAPTERS CORNER

IEEE GRSS CHAPTER OF THE AUSTRALIAN CAPITAL TERRITORY AND NEW SOUTH WALES JOINT SECTIONS

Xiuping Jia, School of Engineering and Information Technology, University of New South Wales at the Australian Defence Force Academy, Canberra, Austalia, E-mail: x.jia@adfa.edu.au

The first IEEE GRSS Chapter in Australia under Australian Capital Territory (ACT) and New South Wales (NSW) joint Sections was formed on 16 May 2010. The chapter chair is Dr. Xiuping Jia, The University of New South Wales at The Australian Defence Force Academy. While the population is low in the region associated to the Sections, this chapter is composed of members from university, government and industry sectors. The membership covers a full spectrum of the IEEE grades. Prof. John Richards of The Australian National University has been awarded Life Fellow since last year. Prof. Anthony Milne of The University of New South Wales, the past President of GRSS, has been awarded IEEE Fellow recently.

Dr. Xiuping Jia, Chair of the Australian Capital Territory and New South Wales joint Sections Chapter.

Dr. Zhi Huang has been upgraded to Senior Member with the support from the members in this chapter. The student membership has continuously increasing.

This chapter organized a successful presentation by Prof. John Richard in Oct 2010 titled 'Remote Sensing in Australia: Challenges Past and Present'. About 40 members and guests attended the event. They were pleased to learn the development of remote sensing programs and image processing tools in Australia and were inspired with the challenges and future research directions John presented. This year will see a full scale function of the chapter including membership promotion and technical activities.

IEEE GRSS FRENCH CHAPTER

Jocelyn Chanussot, GIPSA-Lab, Grenoble Institute of Technology, France
Grégoire Mercier, Télécom Bretagne, Brest, France

History

The French community in geoscience and remote sensing has been very active over the past decades, with a lot of academic research labs, the French space agency (CNES), and numerous industrial partners (Thales, Sagem, Eurocopter, Magellium, CS, CLS etc...).

This community has been deeply involved for years in GRSS activities, and the GRSS French Chapter was finally officially founded in 2007 with the following board:

Jocelyn Chanussot	Grenoble Institute of Technology	President
Grégoire Mercier	Telecom Brest	Secretary
Didier Massonnet	CNES Toulouse	Treasurer

As illustrated in this report, the actions of the Chapter consisted in:

- promoting geoscience and remote sensing activities among researchers, PhD students and industrial partners, but also under-graduate and graduate students through summer programs.
- promoting the IEEE GRSS as the leading society in this field,
- working in collaboration with other existing structures at the national level.

Main Actions

Technical Meetings

The chapter has every year a number of technical meetings. It can be at the occasion of a PhD dissertation, gathering several

Jocelyn Chanussot, (second from left) and Grégoire Mercier (second from right) receive the Chapter Excellence Award for the French Chapter, with GRSS President Alberto Moreira (right) and Awards Co-Chair Martti Hallikainen at IGARSS 2010.

members from different cities. It can also be at the occasion of one-day thematic workshops. These workshops have been organized in collaboration with the French GDR ISIS (working group on Information Signal, Images and viSion). In particular, the Chapter was involved in two specific actions:

- one action on Change Detection
- one action on Multivariate Image Processing

In average, these workshops are held 2 times every year, gathering around 50 people. Each day starts with a plenary introduction (Jon Atli Benediktsson, Lorenzo Bruzzone, Ridha Touzi have been such guest speakers over the past few years) and a brief presentation of GRSS. These invited talks are then followed by 6 to 8 presentations by researchers or PhD students from all over the country.

Summer School

In 2008, a summer school on very high resolution remote sensing has been organized in Grenoble. During 5 days, the program included 28 hours of lectures and 6 hours of lab sessions. The lectures were given by prestigious European experts and the event gathered around 60 attendees, both academics (researchers and PhD students) and industrial partners.

Special Issue of *Traitement Du Signal*

In 2009, the Chapter Board edited a special issue of the French Journal "Traitement du Signal". The topic of the special issue was "remote sensing for the monitoring and the management of the environment" and 6 outstanding contributions were selected, addressing various topics in remote sensing, from the monitoring of glaciers using interferometric SAR data to the counting of birds using high resolution optical data or the monitoring of tropical forests.

Edited Book

In 2010, an Edited Book on "Multivariate Image Processing" is published by ISTE London and Wiley, USA. This book contains a set of chapters written by the participants of the thematic workshops previously described (for instance on change detection, pansharpening, spectral-spatial classification in hyperspectral imagery...), most of the times in association with some foreign colleagues in order to increase the potential readership.

Electronic Newsletter

An informal newsletter is sent to all the French GRSS members anytime some relevant information is available. The table below presents a typical table of content of one electronic newsletter. It includes information about the election of the new board, some call for papers (for conferences and IEEE Journals), one job offer in hyperspectral processing, 2 Master Thesis/PhD offers, a call for participation for the next thematic day (on object recognition) and a (re-)call to include PhD reports on the GRSS website.

Beyond GRSS members, the newsletter is also sent to around 300 people involved in remote sensing. This is also a way to remind everyone of GRSS and stimulate membership (see item 2.6).

Newsletter aperiodique du Chapitre France IEEE Geoscience and Remote Sensing Society (sorry for multiple postings!)

Table of content of the Electronic Newsletter.

1) Election du nouveau bureau IEEE GRSS, chapitre France
2) Conference IEEE GRSS Workshop on Hyperspectral Image and Signal Processing (WHISPERS)
3) Poste CDI imagerie hyperspectrale, societe Actimar
4) Offre de stage + these, radar, SONDRA/Supélec et SATIE/ENS Cachan
5) Offre de stage en recalage d'images, EADS
6) Journee Reconnaissance d'objets en imagerie spatiale du GDR ISIS (debut mai, deadline de proposition: 20 mars)
7) Numero special "Advances in Remote Sensing Image Processing", IEEE Journal of Selected Topics in Signal Processing

8) Numero special "spectral unmixing of remotely sensed data", IEEE Transactions on Geoscience and Remote Sensing
9) Vos theses en teledetection sur le site IEEE GRSS
10) Abonnement / désabonnement / contributions

GRSS PhD Excellence Award

In 2009, the French Chapter initiated an European action: a GRSS PhD Excellence award has been established. 5 PhD have been awarded with a good thematic and geographical balance.

T. Peng, who prepared her PhD under the supervision of J. Zerubia received one of these awards in the name of the French Chapter for her thesis on "New higher order active contour models, shape priors, and multiscale analysis, their application to road network extraction from very high resolution satellite images".

Statistical Features

In order to support the excellence of the French Chapter activities, we provide the following features comparing the number of GRSS members in 2010 and in 2006, right before the Chapter was founded. It shows a significant increase of 60% in terms of membership.

	2006	2010	Difference
Fellows	0	2	+2
Senior Members	10	13	+3 (+30%)
Members	37	71	+34 (+92%)
Grad. and students	8	7	-1 (-12,5 %)
Affiliate or associate	10	11	+1 (+10%)
TOTAL	65	104	+39 (+60%)

Chapter Excellence Award

As a recognition of its activities, the French chapter received the IEEE GRSS 2010 Chapter Excellence Award, "for excellence as a GRSS chapter demonstrated by exemplary activities during 2009". Jocelyn Chanussot and Grégoire Mercier received the IEEE Certificate at IGARSS 2010 in Honolulu, Hawai, at the Awards ceremony held during the banquet. In addition to the Certificate, the award also consists in an honorarium of $1,000 to be used for Chapter activities. This money will be used in 2011 to support the participation of some PhD students to IEEE GRSS sponsored conferences.

New Board and Future Actions

A living community is a community where everyone can be involved and bring new ideas. Bringing new active and highly motivated members to the board of the chapter is a good way to generate new activities. Consequently, after 3 years, Jocelyn Chanussot stepped down and a new board was elected in 2010 for a 3 years term:

Grégoire Mercier	Telecom Brest	President
Roger Fjortoft	CNES Toulouse	Secretary
Rodolphe Marion	CEA Paris	Treasurer

The GRSS French Chapter is still taking specific care on information diffusion. A website is under construction and will open in 2011. It will relay information of interest (such as deadlines, call for papers for national and international conferences and workshops) for the French geoscience and remote sensing community. It will also centralize the PhD thesis (written in French) on the field of remote sensing as it is the case on the GRSS website. In this way the aim of the French GRSS Chapter is to relay activities of the GRS Society down to the national scale.

AMENDMENTS TO THE GRSS BYLAWS

Jón Atli Benediktsson
GRSS President
January 28, 2011

The changes to the GRSS Bylaws and Constitution detailed below were approved by the Administrative Committee (AdCom) at a meeting on Nov. 6, 2010. The changes below will go into effect within 30 days of publication unless ten percent of Society members object. A copy of the GRSS Bylaws documents is available on the GRSS website. ***Inclusions are in blue color, deletions are with the strikethrough in red.***

GRSS BYLAWS

II. Elections and Officer Duties

7. Executive Vice-President *(from page 7 of the GRSS Bylaws)*

In the President's absence or incapacity, his/her duties shall be performed by the Executive Vice-President. The Executive Vice-President will have report to him/her the Chair of the Constitution and Bylaws Committee, the Operations and Procedures Manual Committee~~,~~ and the IEEE Committee on Earth Observation (ICEO) ~~and the History Committee~~, and will also serve as Chair of the Strategic Planning Committee.

12. Vice-President of Information Resources *(from page 8 of the GRSS Bylaws)*

The Vice-President of Information Resources is an elected member of AdCom appointed by the President. Reporting to the Vice-President of Information Resources are; the society representative for the IEEE Professional Activities Committee for Engineers (PACE), the Director of Corporate Relations, the Director of Education, the Web Editor, the Newsletter Editor, the History Committee and the Chair of the Publicity and Public Relations Committee. The Publicity and Public Relations Committee plans, prepares, and implements publicity and public relations for the Society. The Vice-President of Information Resources will provide regular reports to AdCom on website development and initiatives implemented to support member services and designed to increase society visibility and public outreach. The Vice-President of Information Resources will also provide recommendations to AdCom on how the Society can more effectively engage with industry and contribute to educational programs.

(President's Message continued from page 3)

IGARSS 2011 team has done an excellent job in preparing for the conference, and the technical program is truly outstanding.

Small symposia are growing in importance in the GRSS portfolio. Last year, the GRSS co-sponsored ten small symposia in many different parts of the globe, and many such events will be held this year as well. I am happy to tell you that I started the year by giving an invited talk at a successful GRSS technically co-sponsored small symposium in Xiamen, China. It was an excellent experience to meet people there and discuss the GRSS.

The GRSS has now established a task force to enhance its globalization initiatives and to better prioritize the focus of GRSS membership activities. The GRSS is working on several initiatives (including workshops, chapters, tutorials, technical co-sponsorship for specialty symposia, and travel support) to increase GRSS involvement and representation in Latin America, Africa and the Asia-Pacific region.

Our major regional activities are performed through chapters. GRSS now has a total of 35 chapters on six continents, including two student chapters. The chapters provide an excellent opportunity to network with colleagues and experts in the local member community. Furthermore, the chapters can invite speakers from the GRSS' outstanding Distinguished Speakers program to speak at chapter meetings. During the past year, six new GRSS Chapters were formed, one in South Africa (Joint

(continued on page 43)

CALL FOR PAPERS

IEEE Transactions on Geoscience and Remote Sensing
Special Issue on ESA's Soil Moisture and Ocean Salinity Mission — Instrument Performance and First Results

Focus

The European Space Agency's (ESA) Soil Moisture and Ocean Salinity (SMOS) Mission was launched in November 2009 and has since provided soil moisture and ocean salinity data on a global scale. Soil moisture observations will further our knowledge about processes in the water and energy fluxes at the land surface whereas ocean salinity measurements will aid the characterization of global ocean circulation and its seasonal and inter-annual variability. SMOS observations will also provide information on the characterisation of ice and snow covered surfaces and the sea ice effect on ocean-atmosphere heat fluxes and dynamics.

In support of the scientific requirements a novel technology was implemented: The payload of SMOS consists of the Microwave Imaging Radiometer using Aperture Synthesis (MIRAS) instrument, a 2-D interferometric radiometer operating at L-Band (1.4 GHz, 21 cm), measuring the brightness temperature emitted from the Earth at L-band over a range of incidence angles (0 to 55°) across a swath of approximately 1000 km. The main challenge for MIRAS has been to achieve the finest spatial resolution ever with a space-borne L-band radiometer over a wide swath. MIRAS is a truly novel instrument which synthesizes a large aperture from a two-dimensional array of small passive microwave radiometers.

During the first year in orbit the focus has been on the calibration of the MIRAS instrument and the validation of the data, which will be the focus of this special issue. Hence we would like to invite contributions covering the following topics:

- Calibration and performance of the MIRAS instrument
- First results of calibration and validation and scientific studies using SMOS data, including results from in-situ and airborne campaigns, retrieval algorithm development and activities under ESA's Announcements of Opportunity for i) SMOS calibration and validation, and ii) scientific studies
- Contributions focusing on assimilating SMOS data into predictive models and developing new products based on SMOS data

Submission Guidelines

Prospective authors should follow the regular guidelines of the IEEE Transactions on Geoscience and Remote Sensing (TGRS), as listed in the back cover of the Transactions. Authors should submit their manuscripts electronically to http://mc.manuscriptcentral.com/tgrs. Instructions for creating new accounts, if necessary, are available on the login screen. Please indicate in your submission that the paper is intended for the Special Issue by selecting "*ESA's SMOS Mission*" from the pull-down menu for manuscript type. Questions concerning the submission process should be addressed to tgrs-editor@ieee.org. For this Special Issue, authors are encouraged to contribute to the voluntary page charges.

Guest Editors of the SMOS Special Issue are

Susanne Mecklenburg
European Space Agency

Yann Kerr
Centre d'Etudes Spatiales de la BIOsphère (CESBIO), FRANCE

Jordi Font
Institut de Ciences del Mar (ICM), CSIC, SPAIN

Manuel Martín-Neira
European Space Agency, ESA-ESTEC

Inquires concerning the Special Issue should be directed to:

Susanne Mecklenburg
SMOS Mission Manager
European Space Agency
susanne.mecklenburg@esa.int
Tel: ++39 06 94180 695

Submission Deadline: March 31, 2011, with final publication in the May 2012 issue.

2011 IEEE International Geoscience and Remote Sensing Symposium

SENDAI 仙台 2011 IGARSS

IEEE Advancing Technology for Humanity

IEEE GRSS Geoscience and Remote Sensing Society

August 1-5, 2011, Sendai Japan

Beyond the Frontiers: Expanding our Knowledge of the World

Welcome

On behalf of the IEEE Geoscience and Remote Sensing Society and the IGARSS 2011 Organizing Committee, we are pleased to invite you to Sendai, Japan for IGARSS 2011. Sendai hosts a famous summer festival "Tanabata", or "star festival", every August. Only once a year Vega and Altair can meet in the sky, but only if it is not raining. On the last day of IGARSS2011, a large fireworks festival will take place near the conference venue, which will be the start of Tanabata for 2011. We will celebrate in hopes of a clear sky for Vega and Altair. To enjoy glittering stars in the sky, we must keep the atmosphere and the earth clean. It is our task to observe the earth's environment, and it is the work of geoscience and remote sensing technology to aid us in this task. We cannot touch the stars, but we can explore them by remote sensing technology. We are surrounded by many different types of frontiers. Remote sensing is a technology that can expand our knowledge beyond these frontiers. We can observe the earth's environment on a global scale, beyond that which can be seen through our own eyes. Subsurface sensing that is applied below the surface of the ground and the ocean, and even beneath the surface of man-made construction, provides us with knowledge of the unknown world. Boundaries between countries have no meaning when the earth's environment is observed by remote sensing technology. In addition to the observation, technologies to store and utilize the information are also quite important for earth's environment. We hope IGARSS2011 will provide you with the opportunity to think about how we can expand our frontiers. We look forward to seeing you in Sendai in August 2011.

IGARSS2011 General Chair Motoyuki Sato

Please visit http://igarss11.org/ for more information and online registration/hotel reservation.

Access to Sendai

Sendai is located approximately 300 kilometers (180 miles) north of Tokyo.
Recommended route from Narita Int. Airport:
1. Narita Intl. Airport >> Sendai Airport (60 min. by air) >> Sendai Sta. (20 min. by train)
2. Narita Intl. Airport >> Ueno Sta. (41 min. by Keisei train) >> Sendai Sta. (100 min. by JR bullet train)
3. Narita Intl. Airport >> Tokyo Sta. (60 min. by JR express train) >> Sendai Sta. (about 100 min. by JR bullet train)

GPR 2012:

Sustainable Development of Ground Penetrating Radar for Engineering and Environment

June 4-8, 2012
Shanghai, China

Tongji University
National Natural Science Foundation of China

GPR 2012 Chair:
Prof. Yongsheng Li --Tongji University

Abstract submission:
Before November 15, 2011
Extensive abstract
Email: xiexiongyao@tongji.edu.cn
copy zhaoyh@tongji.educn

Early Bird Registration:
Before April 30, 2012

Registration fees:
CNY 4000

Web Address:
http://www.gpr2012.org

The 3rd International Conference

Microwaves, Radar and Remote Sensing Symposium

25-27 August 2011,
Kiev, Ukraine

MRRS 2011

http://ieee.nau.edu.ua/index-22.html

Organized
by the IEEE Ukraine SP/AES Joint Chapter (Kiev)
and the National Aviation University, Kiev, Ukraine

Symposium Chair:
Prof. Felix Yanovsky, IEEE Fellow

Contribution Submission:
Camera-ready 4-page papers by April 20, 2011

e-mail to: yuliya-ans@yandex.ru; yanovsky@i.com.ua

Publications: Conference Proceedings book, CD, IEEE Xplore, and extended versions of the selected papers in the International Journal of Microwaves and Wireless Technologies (http://journals.cambridge.org/mrf)

33rd Review of Atmospheric Transmission Models Conference

14-16 June 2011
National Heritage Museum • Lexington, Massachusetts

CALL FOR PAPERS

The conference will provide scientists, engineers, and technical managers from academia, industry, government, and the military with a forum to present their research and exchange ideas on all aspects of atmospheric science as it effects radiative transfer and the retrieval of atmospheric and surface properties. Papers on phenomenologies associated with diverse aspects of earth-atmospheric radiative transfer, including cloud and aerosol effects, surface characterization, solar illumination, littoral interfaces, and polarization, are especially welcome. This will be an unclassified meeting featuring renowned keynote speakers and technical program sessions. For program consideration, abstracts should be submitted to ieeegrss@ieee.org no later than 29 April 2011.

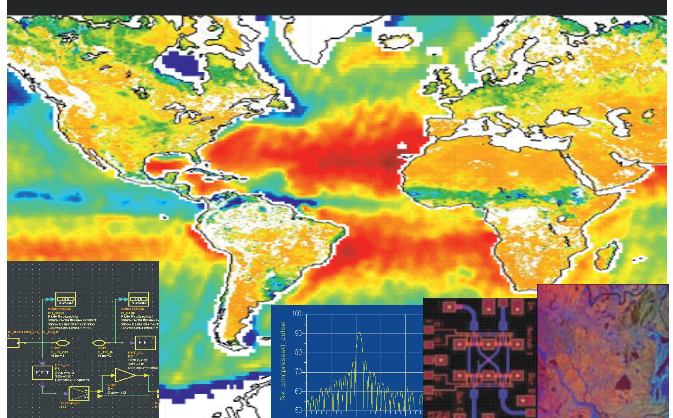
Honored guest speakers — Thomas von Clarmann, Radiative Transfer Algorithms; Manuel Lopez-Puertas, Non-LTE Effects; Christian Hill and Peter Bernath, Spectroscopy; Stephen Tjemkes, Radiative Transfer Requirements for Accurate Retrieval; and Joseph Shaw, Polarization Effects in RT Modeling.

Abstract Deadline:
29 April 2011

For more information, visit http://www.grss-ieee.org .

ARSI 2011

Advanced RF-Sensors and Remote Sensing Instruments



Credits for main image: CESBIO, IFREMER, CATDS

13 - 15 September 2011

ESTEC - European Space Research and Technology Centre Noordwijk, The Netherlands

Abstract submission deadline: 22 May 2011

http://conferences.esa.int/
ESA.Conference.Bureau@esa.int

Co-organized with IEEE-GRSS TC on Instrumentation and Future Technology

Organizers:
Christopher Buck – ESA
Michael Ludwig – ESA
Eastwood Im – NASA/JPL
Martin Suess – ESA

UPCOMING CONFERENCES

See also http://www.techexpo.com/events or http://www.papersinvited.com

Name: Seventh conference on Image Information Mining
Dates: March 30–April 1, 2011
Location: Ispra, Italy
Contact: Dr. Roger King
E-mail: rking@cavs.msstate.edu
URL: http://earth.eo.esa.int/rtd/Events/2011_ESA-EUSC-JRC/index.html

Name: EARSeL 7th Workshop of EARSeL Special Interest Group "Imaging Spectroscopy"
Dates: April 11–13, 2011
Location: Edinburgh, UK
E-mail: earsel2011@ed.ac.uk
URL: http://www.earsel2011.com/Welcome/

Name: Joint Urban Remote Sensing Event (JURSE 2011)
Dates: April 11–13, 2011
Location: Technische Universitaet Muenchen (TUM), Muenchen, Germany
URL: http://www.pf.bv.tum.de/jurse2011/

Name: Earth Observation for Global Changes (EOGC 2011)
Dates: April 13–15, 2011
Location: Technische Universitaet Muenchen (TUM), Muenchen, Germany
URL: http://www.eogc2011.tum.de

Name: 2011 IEEE Radar Conference (RadarCon '11)
Dates: May 23–27, 2011
Location: Kansas City, Missouri, USA
Contact: Dr. James Stiles
E-mail: jstiles@ittc.ku.edu
URL: http://www.ieeeradarcon11.org/

Name: 31st EARSeL Symposium "Remote Sensing and Geoinformation not only for Scientific Cooperation"
Dates: May 30–June 3, 2011
Location: Czech Technical University in Prague, Czech Republic
Contact: Lena Halounová
E-mail: lena.halounova@fsv.cvut.cz
URL: http://www.earsel.org/symposia/2011-symposium-Prague/

Name: 3rd EARSeL Workshop on Education and Training
Dates: May 31, 2011
Location: Czech Technical University in Prague, Czech Republic
Contact: Rainer Reuter
E-mail: rainer.reuter@earsel.org
URL: http://www.earsel.org/SIG/ET/3rd-workshop/index.php

Name: 4th EARSeL Workshop on Remote Sensing for Land Use & Land Cover
Dates: June 1–3, 2011.
Location: Czech Technical University in Prague, Czech Republic
Contact: Matthias Braun, Ioannis Manakos
E-mail: mabra@gi.alaska.edu, manakos.earsel@gmail.com
URL: http://www.earsel.org/SIG/LULC/index.php

Name: 5th EARSeL Workshop on Remote Sensing of the Coastal Zone
Dates: June 1–3, 2011
Location: Czech Technical University in Prague, Czech Republic
Contact: Antonio Palucci
E-mail: palucci@frascati.enea.it
URL: http://www.earsel.org/SIG/CZ/5th-workshop/index.php

Name: 1st EARSeL SIG Forestry workshop: Operational remote sensing in forest management
Dates: June 2–3, 2011
Location: Czech Technical University in Prague, Czech Republic
Contact: Filip Hájek, Piotr Wężyk
E-mails: hajek.filip@uhul.cz, rlwezyk@cyf-kr.edu.pl
URL: http://www.earsel.org/SIG/Forestry/call.php

Name: 3rd Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (Whispers 2011)
Dates: June 6–9, 2011
Location: Lisbon, Portugal
E-mail: info@ieee–whispers.com
URL: http://ieee–whispers.com/

Name: 5th Recent Advances in Space Technologies (RAST2011)
Dates: June 9–11, 2011
Location: Istanbul, Turkey
Contact: Dr. Okyay Kaynak
E-mail: okyay.kaynak@boun.edu.tr
URL: http://www.rast.org.tr/

Name: Geoinformatics 2011
Dates: June 16–18, 2011
Location: Shanghai, China
Contact: Dr. Xinyue Ye
E-mail: xye@bgsu.edu
URL: www.geoinformatics2011.org

Name: 25th International Cartographic Conference
Dates: July 3–8, 2011
Location: Paris, France
URL: http://www.icc2011.fr/

Name: 6th International Workshop on the Analysis of Multi-Temporal Remote Sensing Images (Multitemp 2011)
Dates: July 12–14, 2011
Location: Trento, Italy
Contact: Dr. Lorenzo Bruzzone
E-mail: multitemp2011@disi.unitn.it
URL: http://multitemp2011.org/

Name: 2011 IEEE Geoscience and Remote Sensing Symposium (IGARSS2011)
Dates: July 31–August 5, 2011
Location: Sendai, China
URL: http://igarss11.org/

Name: The 2011 International Symposium on Image and Data Fusion (ISIDF2011)
Dates: August 9–11, 2011
Location: Tengchong, Yunnan Province, China
Contact: Dr. Yu Zeng
E-mail: zengyu@casm.ac.cn
URL: www.isidf2011.casm.ac.cn

Name: Pattern Recognition in Remote Sensing-Workshop
Dates: August 10, 2011
Contact: Dr. Nicolas H. Younan
E-mail: younan@ece.msstate.edu
URL: http://www.iapr–tc7.org/prrs10

Name: XXX URSI General Assembly and Scientific Symposium of International Union of Radio Science (URSI GASS 2011)
Dates: August 13–20, 2011
Location: Istanbul, Turkey
E-mail: ursigass2011@ursigass2011.org
URL: http://www.ursigass2011.org/

(continued on page 44)

(President's Message continued from page 38)

Chapter); Brazil (Student Chapter); Nanjing, China; Australian Capital Territory and New South Wales, Australia; Gambia, Africa; and Vancouver, Canada (Joint Chapter). Other chapter formation initiatives are in process in the diverse locations of India, Turkey, Mexico, Croatia, Indonesia, Alaska, and Dayton, Ohio. Please check our web site for the GRSS Chapter point of contact nearest to your home city.

If you have suggestions concerning GRS Society activities, please do not hesitate to be in touch. We are looking forward to increasing our member services and thereby the value of GRSS membership.

Finally, I would like to congratulate our five new IEEE Fellows (Class of 2011): Adriano Camps, Anthony Milne, Eric Pottier, Paul Rosen, and Masanobu Shimada, In addition, five other GRSS members were elected to IEEE Fellow through nominations submitted by other IEEE societies: Donald Barrick (Ocean Engineering Society), Maria Greco (Aerospace and Electronic Systems Society), Paul Gader (Computer Intelligence Society), Arun Hampapur (Computer Society), and Eric Mokole (Aerospace and Electronic Systems Society). Congratulations to all new IEEE Fellow members for this most distinguished recognition!

We are certainly looking forward to an exciting 2011 in geoscience and remote sensing research and applications.

With my warmest wishes,

Jón Atli Benediktsson
President
IEEE Geoscience and Remote Sensing Society
benedikt@hi.is

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(UPCOMING CONFERENCES continued from page 36)

Name:	The 3rd International Microwaves, Radar and Remote Sensing Symposium (MRRS-2011)
Dates:	August 25–27, 2011
Location:	Kiev, Ukraine
Contact:	Dr. Yuliya Averyanova
E-mail:	yuliya-ans@yandex.ru
URL:	http://ieee.nau.edu.ua/index-22.html

Name:	Advanced RF Sensors and Remote Sensing Instruments Workshop
Dates:	September 13–15, 2011
Location:	Noordwijk, The Netherlands
Contact:	Dr. Martin Suess
E-mail:	Martin.Suess@esa.int
URL:	http://conferences.esa.int/

Name:	International Conference on Space Technology (ICST 2011)
Dates:	September 15–17, 2011
Location:	Athens, Greece
Contact:	Dr. Maria Petrou
E-mail:	Maria.petrou@imperial.ac.uk
URL:	http://www.icspacetechnology.com/

Name:	Asia-Pacific Conference on Synthetic Aperture Radar (APSAR2011)
Dates:	September 26–27, 2011
Location:	Seoul, Korea
Contact:	Prof. Youngkil Kwag
E-mail:	ykwag@kau.ac.kr
URL:	http://www.kiees.or.kr/

Name:	14th International Conference on Ground Penetrating Radar (GPR2012)
Dates:	June 7–9, 2012
Location:	Shanghai, China
Contact:	Dr. Xiongyao Xie
E-mail:	xiexiongyao@tongji.edu.cn
URL:	www.gpr2012.org

Name:	39th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events (COSPAR 2012)
Dates:	July 14–22, 2012
Location:	Mysore, India
E-mail:	cospar@cosparhq.cnes.fr
URL:	http://www.cospar-assembly.org