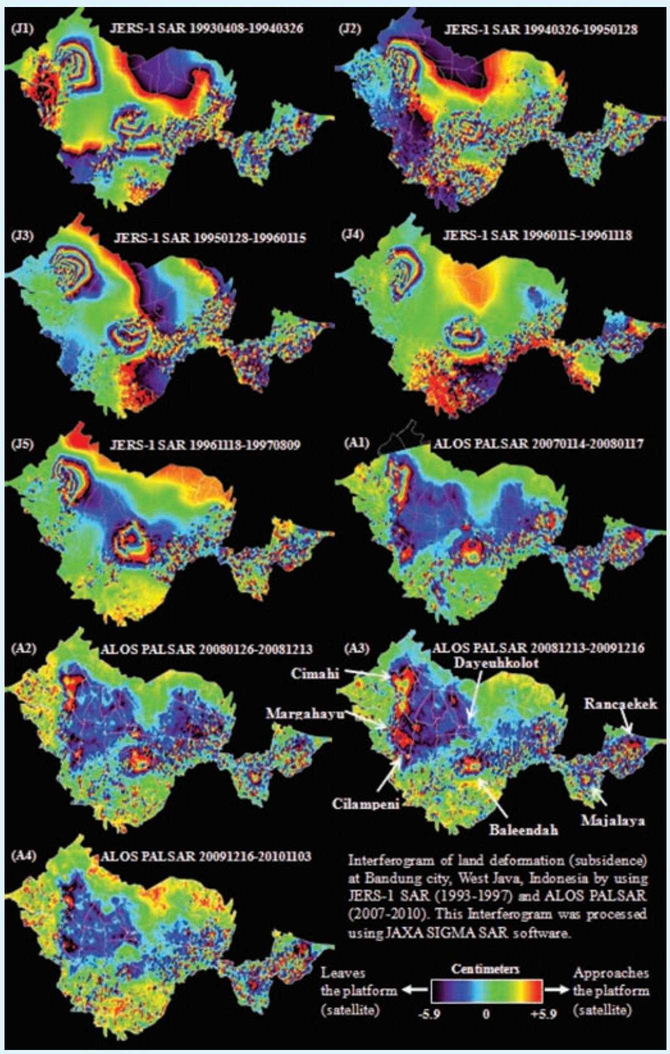
IEEE GEOSCIENCE and REMOTE SENSING

Newsletter

http://www.grss-ieee.org/menu.taf?menu=Publications&detail=newsletter **Editor:** Lorenzo Bruzzone



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Newsletter Input and Deadlines

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

GRSS Newsletter Schedule

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

IEEE GRSS AdCom, Officers and Committee Chairs – 2011 GRS-29 (Division IX)

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This issue of the IEEE Geoscience and Remote Sensing Newsletter is the first after the earthquake and tsunami that affected Japan in March 2011. This was a terrible disaster that strongly affected our Japanese friends and colleagues. Our prayers and thoughts are with them. I am sure they will be able to recover quickly from this tragedy.

In this issue we have many interesting contributions dealing with both scientific and technical topics of remote sensing, as well as with the activities of the IEEE Geoscience and Remote Sensing Society (GRSS).

The *Features* section includes two main contributions. The first article is a tutorial paper on accuracy assessment in the classification of remote sensing images. The article addresses a very important problem in the analysis of remote sensing data, which is related to the validation of classification results. Even though the article focuses on the specific problem of the analysis of classification results, many of the issues discussed are of broader interest and are relevant for many different domains of remote sensing data analysis. The issues of validation and of the definition of reliable, standardized and robust protocols for accuracy assessment are often overlooked, with potentially dramatic implications on the quality of the products generated by remote sensing. This, in turn, has negative effects on the credibility of remote sensing results in operational applications. The second feature article addresses the issue of the final goal of a scientific/technical article from an original perspective. The authors point out the problems of dissemination to the scientific community not only the successful results associated with novel algorithms, systems, and applications, but also the failures that are a necessary part of research activities. The message of the paper is that in selected cases disseminating the negative results obtained in the practical development of very promising ideas can enrich the scientific community and avoid other researchers' efforts to study promising directions that other colleagues already identified as ineffective. I am sure that this short article will stimulate discussion on this relevant issue.

The *Book Review* column presents an overview of *Optical Remote Sensing – Advances in Signal Processing and*

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President's Message

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On behalf of the IEEE Geoscience and Remote Sensing Society (GRSS), I invite you to participate in our annual International Geoscience and Remote Sensing Symposium (IGARSS). This year IGARSS 2011 will be held at the Conference Center in Vancouver, BC, Canada from July 24–29 (please refer to www.igarss11.org for more information). As you may know, the original plan was to hold the conference in Sendai, Japan. However, because of the terrible earthquake and tsunami disaster in Japan, the Geoscience and Remote Sensing Society (GRSS) and the IGARSS 2011 Local Organization Committee (LOC) jointly decided to move IGARSS 2011 to Vancouver. This was a very difficult decision for both the GRSS and the LOC that had worked so hard in the preparations for IGARSS 2011 in Sendai under the outstanding leadership of Motoyuki Sato. All of us were very much looking forward to the conference in Sendai. It was not possible due to the terrible tragedy the Japanese nation has endured. Our greatest sympathy goes to the Japanese people, and we very much admire their courage and resilience.

We are very fortunate to have secured an alternative venue for IGARSS 2011 in Vancouver, BC, Canada. To move a large conference on a very short notice is not easy. The relocation of IGARSS 2011 was made possible by an outstanding team. In particular, I would like to thank Billene Mercer and her company, Conference Management Services (CMS), for

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Cover Information: Monitoring of subsidence in Bandung city, Indonesia using DInSAR of JERS-1 and ALOS PALSAR images. For more information see the article on the "Microwave Remote Sensing Research and Education at Center for Environmental Remote Sensing, Chiba University," which begins on page 32.

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

Exploitation Techniques, edited by Saurabh Prasad, Lori M. Bruce, and Jocelyn Chanussot. The review of this interesting book was written by John Richards, Emeritus Professor in the College of Engineering and Computer Science, Australian National University.

The *Reports* section contains two main contributions. The first recognizes the Best Reviewers for 2010 of the *IEEE Transactions on Geoscience and Remote Sensing* (TGRS), the *IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing* (JSTARS), and the *IEEE Geoscience and Remote Sensing Letters* (GRSL). We are all aware of the effort required to complete high quality reviews; therefore, it is important to recognize those who have performed them particularly well. Congratulations to all the recipients of this recognition! The second contribution is a report on the 2011 Joint Urban Remote Sensing Event (2011 JURSE) held at the Technical University of Munich, Germany, on April 10–13, 2011.

The *Technical Committee Corner* column contains an article describing the activities of the Data Archiving and Distribution Technical Committee (DAD-TC), which focuses on diverse aspects of managing remotely sensed data throughout their life cycle. The article presents the current status of the committee, its initiatives and accomplishments, as well as related research priorities.

The *University Profile* column describes microwave remote sensing research and education at the Center for Environmental Remote Sensing, Chiba University, Japan. The article describes the wide spectrum of activities carried out on remote sensing and its applications at one of the top universities in Japan.

The *Industrial Profile* column introduces the European Centre for Medium Range Weather Forecasts (ECMWF), one of several Numerical Weather Prediction (NWP) centers which will be involved in the evaluation of data from the NPOESS Preparatory Project (NPP) satellite, which is planned for launch in October 2011. Data from two sensors, the Advanced Technology Microwave Sounder (ATMS) and the Cross Track Infrared Sounder (CrIS), will supersede existing operational instruments (AMSU-A and HIRS) and become key components of the satellite observing system over the next decade. This issue is comprehensively covered in the paper.

The *Chapters Corner* column presents the renewed GRSS Distinguished Speakers Program. The article points out the new process to be followed for booking a Distinguished Speaker and the financial support provided by the GRSS to its local chapters in order to cover travel expenses of inviting a speaker. In addition, the article provides bios and topics addressed by the current GRSS Distinguished Speakers. I strongly encourage chapters to take advantage of this excellentprogra m.

I would also like to draw your attention to the calls for nominations for elevation to IEEE Senior Member reported in

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FEATURES

CLASSIFICATION ACCURACY ASSESSMENT

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1. Overview

Image classification analysis for the production of a thematic map is one of the most common applications of remote sensing. It is now widely recognised that accuracy assessment should be seen as a fundamental and integral part of the analysis [1]. Without a rigorous assessment of accuracy the derived map is an untested hypothesis, effectively just a pretty picture of limited scientific value [1, 2]. Indeed so important is the assessment of accuracy that the 'best practices' document on global land cover mapping suggests that one third of the programme's activity should be directed to the assessment of accuracy [1]. Accuracy assessment is also important for other activities within geosciences and remote sensing community. In particular, accuracy assessment is often the basis of evaluations of image processing research. Commonly, for example, the potential of new developments in say classification algorithms, pre-processing techniques or texture descriptors is often illustrated by the effect they have on classification accuracy, with studies typically seeking to show that the new method is in some ways better than or equivalent to some benchmark. Thus, the comparison of classification accuracy statements is also a topic of considerable importance within our community. It is not surprising, therefore, that ~30% of articles published since January 2010 in four of the subject's leading journals (IEEE Transactions on Geoscience and Remote Sensing, Remote Sensing of Environment, International Journal of Remote Sensing and Photogrammetric Engineering and Remote Sensing – web of science search, April 2011) include work that addresses aspects of classification accuracy. Despite the importance of the subject there are many challenges to the derivation of appropriate information on classification accuracy [1,3]. The assessment of classification accuracy can be non-trivial and many issues are actually the focus of considerable research. Perhaps more problematic is that poor attention is sometimes paid to accuracy assessment, with many assessments often seeming to be undertaken as an afterthought and often making use of questionable methods.

This brief article seeks to provide an overview of the basis of accuracy assessment, highlight some key challenges and problems as well as indicate some of the directions for current research. It cannot hope to cover issues in depth but seeks to provide background on some key issues. The article begins by providing an outline of the fundamental basis of accuracy assessment in the next section. It will then briefly discuss what might be considered the basis of the best practice for typical remote sensing scenarios. After laying the foundations to accuracy assessment, attention then turns to some problematic issues including flawed practices that are common. Finally, the article closes with a brief account of some current challenges and research topics.

2. Fundamentals

In remote sensing, accuracy assessment is, essentially, an analysis that seeks to determine the degree of correspondence between the representation of the Earth's surface depicted in an image classification and reality. Thus, the basis of accuracy assessment is simply the comparison of the class labelling derived from an image classifier against some ground reference data set. It can, however, be a distinctly challenging analysis and one that is often undertaken poorly by the geosciences and remote sensing community. This section aims to give an overview of the popular basis to statistically credible accuracy assessment, with some concerns and problems associated with accuracy assessment raised in later sections.

Accuracy assessment has evolved considerably over the history of remote sensing [4]. The issue is, however, complex, partly because of the great diversity of motivations and objectives in accuracy assessment as well as a set of difficulties that are widely encountered. For example, interest may focus on the accuracy of the classification as a whole or on just a sub-set of the classes mapped, and then also from the user's and producer's perspectives depending on the importance of different types of errors [4]. There may also be variations relating to issues such as the cost of different errors which should be integrated into the analysis [5]. Consequently, there is no single universally accepted approach to accuracy assessment but a variety of approaches that may be used to meet the varied objectives that are encountered in remote sensing research. There are however, some general issues that are common to accuracy assessment. Indeed, two broad types of accuracy assessment are popular within remote sensing related research. First, non-site specific accuracy which involves an evaluation of the similarity of the predicted and actual land cover representations in terms of the areal extent of classes in the mapped region. The focus of this type of accuracy assessment is, therefore, on the quantity or coverage of the land cover classes within the region. While this can sometimes be a useful approach to accuracy assessment it is insensitive to the geographical distribution of the classes in the region mapped. Thus, a classified image which contained the classes in correct proportions but in incorrect locations would be deemed perfect. This limitation to the non-site specific approach to accuracy assessment often renders it unsuitable for use in validation programmes and so it is used relatively infrequently. Instead, the second type of approach to accuracy assessment, based on site-specific measures, is more widely used.

Site-specific accuracy assessment involves the comparison of the predicted and actual class labels for a set of specific locations within the region classified. Thus, for example, for a typical remote sensing scenario, the actual and predicted class label information for a sample of pixels drawn from the region mapped are compared. This comparison is typically based upon the cross-tabulation of the actual and predicted class labels. This latter cross-tabulation provides the error or confusion matrix which should provide a wealth of information to summarise the quality of the classification. Indeed the confusion matrix may be used to derive a suite of quantitative measures to express classification accuracy, on both an overall and per-class basis. Site specific accuracy assessment is extremely popular in remote sensing and there is a large literature that promotes it as a 'best practice' [1, 4, 5]. The basis of this approach and some popular methods are outlined in the next section. As will be outlined below, however, it can be a non-trivial analysis and in some instances accuracy assessments based upon the approach may be deeply flawed.

3. The Basis of Best Practice

Although there is no single universally accepted method to accuracy assessment many of the approaches used have a similar basis with measures of accuracy derived from a confusion matrix (Figure 1). Many measures of accuracy exist, often differing only subtly and are commonly highly inter-related [6]. Therefore, in this section an overview of the main basis of accuracy assessment and the key measures only will be provided. A key desire is to ensure that an accuracy assessment provides a rigorous and credible evaluation of the quality of an image classification. Emphasis is placed on typical remote sensing scenarios such as those seeking to describe the accuracy of a map from a sample of observations in a way which allows valid generalizations and inferences to be drawn. For this, the accuracy assessment must be carefully designed. Central to this are the three main components of an accuracy assessment: the response design, sampling design and analysis procedures adopted [7].

The response design is the protocol for the acquisition of the ground reference data labels. This component of an accuracy assessment programme addresses some fundamental but key issues. For example, the spatial support for the accuracy assessment must be selected. Often in remote sensing the pixel

Classifier → \ Ground Data ↓	1	2	3	4	Σ
1	n_{11}	n_{12}	n_{13}	n_{14}	n_{1+}
2	n_{21}	n_{22}	n_{23}	n_{24}	n_{2+}
3	n_{31}	n_{32}	n_{33}	n_{34}	n_{3+}
4	n_{41}	n_{42}	n_{43}	n_{44}	n_{4+}
Σ	n_{+1}	n_{+2}	n_{+3}	n_{+4}	n

Figure 1. The confusion matrix for c=4.The main diagonal, highlighted in grey, contains the correctly allocated cases.

is used as the basis spatial unit but other spatial supports may be used. For example, it is sometimes popular to use a block of pixels or, with the recent growth of object-based classifications, objects such as fields or polygons from a segmentation, may be used. These various spatial units are all appropriate for use in accuracy assessment but they are also different and the differences should be recognised. For example, an object-based approach yields information on the quality of the accuracy with which objects are mapped not of pixels and if objects vary greatly in size this can have important impacts on the derivation of estimates such as of class areal extent.

Given that it is typically impractical to evaluate the entire area of a classified image, accuracy assessment is typically based upon a sample and consequently the nature of the sample used in the accuracy assessment if of fundamental importance to the meaning and credibility of the analysis. Key concerns are the size of the sample [8] and the sampling design used in its collection [9]. The size of the sample is a critical part of the experimental design, not least in relation to the precision with which estimates are derived. Additionally, in order to make rigorous generalizations about the population from the sample, a probability based sampling design should be adopted. There are many sampling designs that are suitable and have been used in remote sensing. These include simple random sampling, stratified random sampling, systematic sampling and cluster sampling [9, 10]. These different approaches vary in suitability for accuracy assessment, notably in relation to the specific objectives of the analysis and the precision of the estimates they derive. These approaches need to be carried out with care and can be undertaken in ways to focus on key accuracy assessment objectives, including cost issues. It is, however, critical that the sampling be undertaken rigorously as failure to correctly implement an appropriate probability sampling design may remove the ability to make rigorous generalization and inferences, greatly limiting the value of the accuracy assessment. Useful guidance on the selection of a sample design is given in [9].

The analysis component of an accuracy assessment includes the specification of the measure(s) that will be used to describe classification accuracy and how they are to be derived from the sample data provided. The end product of this part of the accuracy assessment is a quantitative estimate of classification accuracy, ideally accompanied by standard errors to illustrate the uncertainty that is attributable to sampling variation. Critically, this stage includes the selection of an accuracy measure and the use of a statistically consistent estimation procedure. The latter requires the recognition of the impacts of the selected sampling design on the analysis. Thus, the formulae used in accuracy assessment should be appropriate for the sample. Some of the key formulae for popular sampling designs used in remote sensing are given in [11]. With the selected measure of accuracy and appropriate formulae for estimation, the accuracy assessment is then typically undertaken based on the pattern of class allocation evident in a confusion matrix.

The confusion matrix is central to popular site-specific accuracy assessment. As a simple cross- tabulation of the actual and predicted class labels this should provide a summary of the quality of the class allocations made by the classifier. The matrix highlights on its main diagonal all the cases upon which the labelling agrees, representing the cases for which the classification may be considered to be correct. The off-diagonal elements of the matrix show the mis-classifications (Figure 1). Only two types of error are possible and both are evident in the matrix: omission and commission. The pattern of error can be important and useful in many regards. It could for instance, be used to direct research activity to develop ways to enhance the separability of commonly confused classes. Moreover, the confusion matrix allows the errors, and accuracy, to be evaluated with regard to two perspectives: producer's and user's [4]. Producer's accuracy, P, is a measure of the omission error and indicates the probability that a pixel of a particular class is allocated to that class in the classification. User's accuracy, U, is a measure of the commission error and indicates the probability that a pixel which has been classified into a particular class is actually a member of that class. The marginal values of the confusion matrix may also be used to derive estimates of non-site specific accuracy and can also be used to refine analyses, perhaps by correcting areal estimates for the effect of observed inter-class confusion.

A wide variety of measures of accuracy may be derived from the confusion matrix. Assuming the sample used was acquired following simple random sampling and there are c classes, a simple measure of overall accuracy, O, which may be derived from a confusion matrix is,

$$O = \frac{\sum_{i=1}^{c} n_{ii}}{n} \tag{1}$$

The value derived is often multiplied by 100 and expressed as a percentage. If interest is on the accuracy of the classification of a specific class, class i, this may be derived from the user's perspective by

$$U = \frac{n_{ii}}{n_{i+}} \tag{2}$$

and from the producer's perspective with

$$P = \frac{n_{ii}}{n_{+i}} \tag{3}$$

The fundamental basis of accuracy assessment outlined above may seem quite simple but many concerns are problems are encountered.

4. Problems and Problematic Practices

Built on the above notion of best practice there are some rather problematic practices in accuracy assessment that are sometimes popular and promoted in the remote sensing community. There are many issues and they often act to give a somewhat pessimistic evaluation of classification accuracy [12]. Here, a brief discussion on six major issues is provided.

1) *Kappa coefficient of agreement*. The kappa coefficient has been widely promoted as a measure of classification accuracy in remote sensing. The kappa coefficient, κ, is derived from

$$\kappa = \frac{O - C}{1 - C} \tag{4}$$

where C represents the agreement due to chance. Although widely used and promoted the use of the kappa coefficient as a measure of accuracy has many limitations, some associated with the attributes used to promote the measure in the first place. The four key arguments offered for the use of the Kappa coefficient have typically been that it provides a correction for chance agreement, uses all the entries of the confusion matrix in its calculation, has a scale of measurement to aid interpretation and allows rigorous statistical comparison. The latter is based upon a z test, with the significance of the difference between two kappa coefficients, κ_1 and κ_2, evaluated using

$$z = \frac{K_1 - K_2}{\sqrt{\sigma_{k_1}^2 + \sigma_{k_2}^2}} \tag{5}$$

where $\sigma_{k_1}^2$ and $\sigma_{k_2}^2$ represent the estimated variances of the kappa coefficients and in the common situation of a two-tailed test at the 5% level of significance, a difference is significant if $z>|1.96|$.

However, the arguments used to promote the use of the kappa coefficient are fundamentally flawed [12]. First, chance agreement is of no particular concern to classification accuracy assessment; it does not matter if a pixel is allocated correctly by chance or design. Thus, chance correction is unnecessary. Even if chance correction was desired the standard method to calculate the agreement due to chance is inappropriate for the typical remote sensing scenario and alternatives that are not dependent on the confusion matrix's row marginal may be used [13]. Critically, however, chance correction is unnecessary and the derived coefficient just a downward scaled version of overall accuracy. Second, although only a minor and possibly pedantic issue, the kappa coefficient does not actually use all of the matrix's elements directly but rather only its marginal values. Third, the existence of popular scales for the evaluation of kappa may be useful but these scales are necessarily arbitrary and not of universal applicability. Fourth and finally, the kappa coefficient is not unique in relation to comparisons. In order to rigorously compare two accuracy values all that is normally required are appropriate estimates of the accuracy and the variance of the accuracy for each classification. This is the basis of statistical comparison and may be undertaken with the basic measures such as overall accuracy. Thus, there is a z score based approach to comparing overall accuracy as well as kappa [14]. For example, overall accuracy is just a measure of the proportion of cases correctly allocated by a classifier and the significance of the difference between two proportions, O_1 and O_2, may be derived using a z test, with

$$z = \frac{O_1 - O_2}{\sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \tag{6}$$

where $\bar{p} = x_1 + x_2 / n_{1+}n_2$ with x_1 and x_2 representing the number of correctly allocated cases in the classifications of data sets of size n_1 and n_2 respectively.

Moreover, the often promoted means of comparison of kappa coefficient is for the situation in which independent samples were used in their derivation. Commonly this is not the case in remote sensing and an alternative approach based on related samples such as the McNemar test should be used [14,15].

Fundamentally, as succinctly argued by [16] the various kappa coefficients used "are useless, misleading and/or flawed … in remote sensing". In short, therefore, the Kappa coefficient typically adds nothing of value to the basic measure of accuracy of overall accuracy, from which it is derived, and so represents an unnecessary and unhelpful extension beyond overall accuracy. The kappa coefficient should not be used as a measure of classification accuracy.

2) *Inappropriate formulae*. Sometimes not only may an inappropriate measure (e.g. kappa) be used but the incorrect formulae are employed. A common problem is that formulae appropriate for use with data acquired following a simple random sampling are used when alternatives to reflect the nature of the sampling design actually adopted should be used. For example, it is common for a stratified random sampling design to be used in the acquisition of the testing set. In this situation the weight of the strata needs to be accommodated and it is typically inappropriate to use the equations associated with simple random sampling. For example, equation 7 rather than equation 1 should be used to express overall accuracy if a stratified random sample was acquired for accuracy assessment.

$$O = (1/N)\sum_{i=1}^{c}(n_{ii}N_{i+}/n_{i+}) \tag{7}$$

where N_{i+} is the number of pixels in the complete region mapped as class i and N the size of the population [11]. Similarly, different equations should normally be used for other measures such as user's and producer's accuracy as well as the variance terms; equations for some of the most common sample designs are given in [11].

There are also concerns in the comparison of accuracy values. Commonly, the same testing set has been used and this should be recognised in the analysis. In such situations the accuracy values may be related and the covariance between them should be included in the analysis. This is particularly important as failure to include the covariance between the estimates will impact on statistical tests and their interpretation. For example, failure to accommodate for the effect of the covariance between two related accuracy values may result in the z value being mis-estimated [14]. It is possible to accommodate for dependence by adding a covariance term, $\sigma_{k_1 k_2}$, [14, 17] such that equation 5 becomes

$$z = \frac{K_1 - K_2}{\sqrt{\sigma_{k_1}^2 + \sigma_{k_2}^2 - 2\sigma_{k_1 k_2}}} \tag{8}$$

However, given the concerns with kappa coefficient discussed above it may be more appropriate, and also easier, to adopt an alternative such as the McNemar test [14] or base the evaluation on the confidence interval of the difference [15].

3) *Unrealistic evaluations*. Even if using basic measures of accuracy such as overall accuracy and the per-class measures of user's and producer's accuracy there are some odd practices occasionally encountered in remote sensing that should be avoided. One is to calculate average user's and/or producer's accuracy. The derived estimates have no real meaning as they relate to a hypothetical, and typically unlikely, situation in which each class occurs in equal proportion [11]. A further unusual

and unnecessary practice is to normalise the confusion matrix. It has been argued that accuracy assessments should sometimes be based on a normalised confusion matrix in which the entries of the confusion matrix are adjusted to force equality of all row and column marginals. The resulting matrix again represents an unlikely scenario and can result in mis-interpretation. For example, the act of normalizing the matrix will conspire to make user's and producer's accuracy equal when they may actually differ substantially. Critically, the accuracy estimates derived from a normalised confusion matrix may be substantially biased [18].

4) *Assessments based on training data.* Sometimes classification accuracy has been evaluated using the training data, perhaps a distinct sub-set used for cross-validation purposes when using a classifier that has parameters that require tuning, rather than an independent testing set. This can be a highly biased analysis. While many of the concerns raised in this article have focused on actions that have a pessimistic effect on accuracy assessment the use of training data for accuracy assessment is well-known as a source of optimistic bias [19]. Thus, while the accuracy with which the training set is classified can be used to provides a general guide to the quality of the classification it must be recognised that accuracy estimates derived may be inflated. There are also important concerns linked to the sampling design. It must be noted, for example, that the objectives of training and testing a classifier are different and so the ideal nature of the samples used for each may differ. The approach to training should be classifier specific – some classifiers require a representative description of each class which might be drawn from a probability sampling design that could be appropriate for use in testing but other approaches to training may be adopted. Some approaches to training may be based upon distinctly unrepresentative samples. For example, a spectrum of pixels in terms of purity may be deliberately used in training a classifier. Some training strategies may focus on using only the spectrally most distinct and homogenous pixels [11] while others may focus at the other extreme and use mixed pixels [20]. These approaches will not provide a representative sample that is typically needed for the purposes of testing. Similarly, accuracy assessments based upon data used cross-validation can be mis-leading and biased, especially if a probability sampling design was not used in their acquisition [11, 21].

5) *Comparative assessments.* There is often a comparative component to an accuracy assessment. Typically, this is comparison to some target or benchmark value or the comparison of accuracy values derived from different classifications. There are many concerns with such comparative assessments in remote sensing and three are highlighted here: (i) In comparison to a target value, it is very common to see reference made to a target accuracy of 85%. This 85% value is often used as if it is some standard universally valid threshold by which to evaluate any image classification. In reality the 85% threshold has a clear history and may have been appropriate for its specific purpose but should not be adopted as a general target. Researchers should set the target for their own investigation, this may be substantially higher or lower than 85% [12]. (ii) Although comparisons inevitably focus on the disparity in the magnitude between accuracy values it is important to be aware of the nature of the difference, especially in relation to the objectives of the analysis. Typically in remote sensing, the disparity between two accuracy values is evaluated with the aid of a statistical test for the difference (e.g. using approaches such as those indicated by equations 5, 6 or 7). However, it is important to recognise that this may not always be appropriate and other scenarios exist. Commonly, for example, in remote sensing applications an aim is to determine if two classifications are similar in accuracy. For example, a project may be evaluating a new inexpensive and quick classifier and wish to see if it performs as well as a standard benchmark. In this type of situation, the aim is, therefore, not to test for the difference but for some form of equivalence, a subtle but important distinction. Just as there are formal tests for the difference there are tests for other disparities. Two that are likely to occur in remote sensing applications are tests for equivalence and non-inferiority [15]. For example, in testing the new classification approach against a benchmark the test of non-inferiority may be appropriate. It is important to use the correct test. For example, it should be noted that a test of difference is inappropriate if seeking to study the similarity of two accuracy values; a non-significant difference is not proof of similarity. In many cases it may be easiest to undertake tests using confidence intervals, which are easy to derive and can convey more information than standard hypothesis tests [15]. (iii) Finally, as with accuracy assessment in general, there is a need to carefully select the sample size for the analysis. Sample size may be estimated using standard equations based on statistical sampling theory. However, in relation to comparative studies there is the need to consider the minimum meaningful difference in accuracy and degree of statistical power in the calculation of required size [8]. This is important in order to avoid the potential of making major errors in hypothesis testing. For example, a test may indicate non-significant difference exists but it is possible that a difference actually does exist but the test lacked the

power to identify it. There is a need to carefully design studies to ensure that the sample size is appropriate to the objectives of a study, recognising that samples that are too small and those that are too large can be a problem. The required sample size may be estimated using standard formulae [8].

6) *Ground truth*. An implicit assumption underlying the standard approach to accuracy assessment in remote sensing is that the ground reference data are a gold standard (100% correct). This is rarely the case and one reason why an expression such as ground data should be used in preference to the term ground truth. While the presence of ground data error is known to occur very little is actually done about it and its presence will often result in an underestimation of the quality of remote sensing classifications [12]. However, researchers need to be aware that even very small errors in the ground data set can be a cause of substantial bias to accuracy assessment [22]. For example, in a simple scenario using ground data that were 90% accurate the estimated producer's accuracy of a classification was approximately half the actual value and the extent of the class over-estimated by a factor of nearly three (see scenario E in [22]; note more extreme scenarios exist). If the quality of the ground reference data is known, it may be possible to remove the negative effects and methods also exist to reduce the bias caused by ground data errors of unknown quality [22, 23].

There are many other sources of error and uncertainty in addition to the set discussed above. This includes issues such as spatial mis-registration of ground and image data sets, temporal differences between image and ground data collection and the purity of the spatial units used [3]. Thus, accuracy assessment is more complex than suggested in the discussion above. In some instances, for example, popular methods to classification may not allow the formation of a standard confusion matrix and so make it impossible to compute some measures of accuracy. This can, for example, be the situation if the one-against-all approach to multi-class classification by a support vector machine is used [24]. Thus, while accuracy assessment may seem superficially to be a straightforward activity there are many sources of difficulty and uncertainty.

5. Research Directions

Given the vast array of potential user objectives as well as the characteristics of remote sensing and ground data, accuracy assessment remains a topic of research. There are many research foci and here attention is focused on three major issues as examples:

1) The standard approach to accuracy assessment described above is based on the assumption that each pixel belongs fully to a single class. This is not always appropriate, especially if mixed pixels are abundant in the image. Soft classifications are often used as a way to allow pixels to have multiple and partial class memberships. The accuracy of a soft classification cannot, however, be evaluated using the standard confusion matrix based approaches. A variety of methods to evaluate soft classifications have been proposed including some that seek to link to the confusion matrix [25, 26] but this is a topic of considerable current research.
2) Over the last few years there has been a rapid growth in inexpensive location-aware devices that have allowed the citizen to become a source of information. People all over the world are now able to provide data to inform the production and evaluation of maps from remotely sensed data. This volunteered geographic information has the potential to greatly enhance many aspects of the mapping process. With regard to accuracy assessment, for example, it is possible to get large samples for testing over large areas and the potential value of this in mapping studies has been recognised [e.g. 27]. However, this information comes at a price. A key concern is that such volunteered geographic information is of unknown and variable quality and trust level. It may also have been derived with an inappropriate sample design. Research to exploit the potential of volunteered geographic information may greatly enhance many aspects of image classification studies.
3) Finally, given the many concerns linked to the quality of the ground data, one current area of research is accuracy assessment without ground data. Ground data are costly to acquire yet imperfect, with even small imperfections a source of significant bias in accuracy assessments [22, 23]. Methods to evaluate accuracy without ground data may sometimes be attractive and one approach that may sometimes be suitable for use in remote sensing is based on latent class modelling [22].

6. Conclusion

Accuracy assessment should be a fundamental part of a classification analysis in remote sensing. The basis of accuracy assessment is straightforward but many problems and challenges occur. It is important that an accuracy assessment be undertaken with care and be designed to ensure that meaningful outputs are derived. Critically, researchers should follow a rigorous methodology closely and not deviate from its demands for convenience since failure to follow correct procedures may act to substantially reduce the value and credibility of the accuracy information derived.

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FAILING AS CHANCE – NEGATIVE RESULTS IN GEOSCIENCE & REMOTE SENSING

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1. Great Ideas Do not Always Work

Many great ideas do not work as expected in experiments or real applications. Often we have good results on simulated data or on one real dataset, but the developed idea just does not work on the next dataset. Some ideas, which sound reasonable in theory, just do not work at all. Although we do not have any data to support our claim, it seems that even most of our ideas or experiments produce negative results. Sometimes we find a way to work around it, sometimes we find another solution for the same problem or even another problem for the solution, but often we have to give up on producing a ground breaking progress on the problem. This is a normal process, this is science.

More often than not, these fail experiments are a great source of learning. In the analysis of a failure we often find the path to a working solution. But sometimes, after spending a while exploring an idea, it could appear that it is the wrong approach and that it can't really work. This type of negative results does not find a place for publication in most traditional journals. Researchers are biased towards publishing good and "successful" results by an innate tendency to confirm their expectations [1] and by their expectations that journal editors and peer reviewers are more likely to reject negative findings [2]. It can be tempting, after reading the description of a failing experiment, to conclude that the failure was obvious. As humans we are also not indifferent from the outcome of our research. Positive results and working hypothesis make us happy [3], but confronted with negative results we get disappointed and we might be tempted to either not spend time publishing it. The negative results presumably stay either unpublished or get somehow turned into positive results [4].

We want to encourage others to see their negative findings as valuable scientific discoveries worth publishing. For this purpose we show one simple example of an idea that didn't work out as expected, but still gained us some valuable results. At the end we discuss the drawbacks of not sharing the negative results, hoping to start a discussion inside our scientific community about the importance of publishing negative results.

2. One Simple Example: Simulation of Persistent Scatterer

2.1 The Idea

Around the year 2000 the Persistent Scatterer InSAR technique (PS-InSAR) has been introduced [5] as a methodology for long-term monitoring of subsidence, preferably in urban environment. In PS-InsAR the interferometric analyses relies on a set of points that are very stable scaterrer throughout the entire image stack (set of images taken at different time), the so-called persistent scatterers (PS). Those PS typically represent metallic structures or double- and triple-bounce reflections. By proper geodetic adjustment PS-InSAR separates the following phase contributions for each persistent scatterer: height, deformation parameter, orbit errors and tropospheric delay. With the availability of high-resolution SAR data from e.g. the German TerraSAR-X satellite, tens to hundreds of persistent scatterers can be identified on a single building [6]. Our idea was the identification of PS belonging to a certain building by identifying possible double- and triple-bounces using SAR simulation and comparing the results from the simulation with the real SAR images and the PS points. A similar approach was later shown more successfully by Auer [7].

2.2 The Experiment

Using a model derived from an airborne laser point cloud we simulated a SAR image with parameters similar to the real SAR image data stack. The simulator used was not able to simulate the phase and also could not precisely simulate the reflection strength, but the single-, double-, and triple-bounce contributions could be separated. Furthermore it could be separated where possible reflections from PS points are located, so that by using the simulation we could determine where any PS is formed and if it is likely to be generated by a single-, double-, or a triple-bouncing.

2.3 The Result

Our experiments trying to determine the location of PS points on building facades using SAR simulation did not really work as well as expected. One major problem was that the building models used for the simulation were not detailed enough. They didn't include the small edges at windows, balconies, air-conditions, etc. that often form PS. So the experiments didn't really work as well as we hoped, but we learned from the failing experiment that it seems that almost no persistent scatterers are formed at the double-bounces between the ground and the building wall. These bright double-bounce lines we could simulate rather precisely, but we found almost no persistent scatterers located on these lines [8].

3. The Drawbacks of not Sharing these Negative Experiences

Based on our experiences, we believe that the reasons for the failing of some ideas during the experimental stage are often

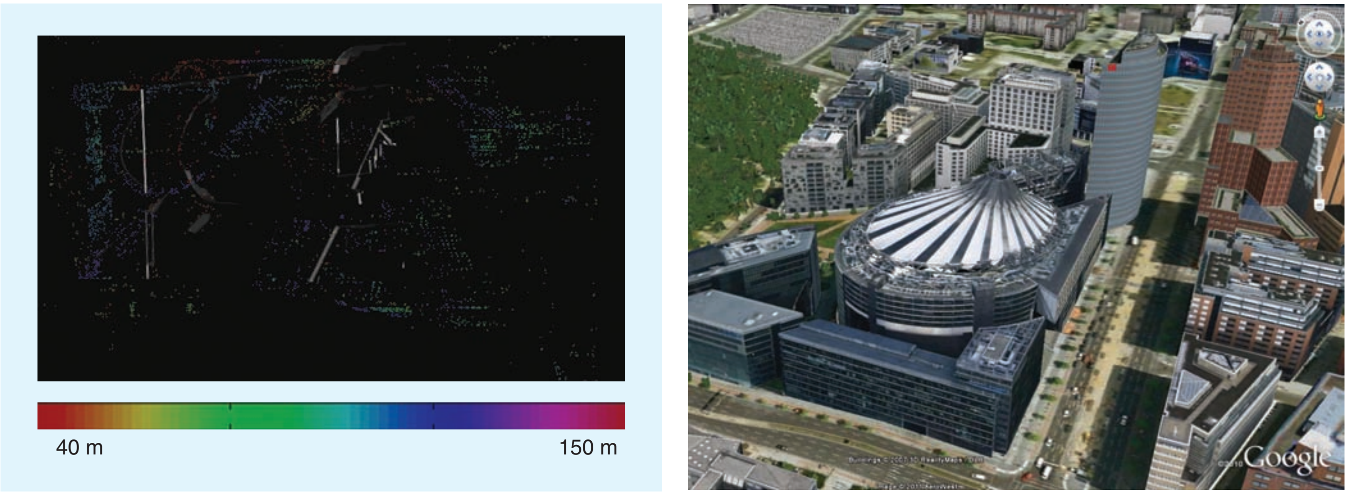

Figure 1. (a) Simulated double-bounce reflections overlaid with persistent scatterers [8]. The color of the scatterers is their estimated height above ground; (b) the test area (Potsdamer Platz in Berlin) as seen in Google Earth™. Buildings © 2007 3D Reality Maps / DLR, Image © 2011 AeroWest.

interesting and their analysis and description can contain important knowledge that deserves to be published. Much can be learned from the analysis of these "failing" ideas. Negative results can be either inspiring other solutions or they can prevent others to explore the same dead end instead spending time on more valuable research. For example, a new PhD students starting on a new subject will have many ideas that do not appear in any paper. These ideas are likely to have been explored before by others, but in the absence of any publication, the student will have to rely on his supervisor intuition that it wouldn't work (and might miss some valuable ideas). Furthermore, other researchers, maybe coming from a different background, may just know how to finally solve the problem or finding a way around it. Through the current selective reporting of results a great amount of useful knowledge disappears and valuable cooperation opportunities are lost. Formulating the issues clearly is often the first step to the solution, but with the current publication setting, the solution is expected with the formulation of the problem (by the same team). All results are equally relevant to science, as long as they have been produced by logic and scientifically methods [4, 9].

In other domains, there are entire scientific journals dedicated to this type of negative results. The Journal of Negative Results in Biomedicine is one important example. In Medicine and Biomedicine, negative results are very important and lifesaving. In other fields there are also various initiatives, like the "Journal of Interesting Negative Results in Natural Language Processing and Machine Learning", the "Journal of Serendipitous and Unexpected Results", or the "The Journal of Spurious Correlations" but the amount of articles published there is rather small.

Nevertheless, we believe in the importance of the publication of negative results. This would give the community the opportunity to publish negative but interesting results and the opportunity to build upon the negative results of others. However, this is a particularly challenging task (it is much harder to explain why something does not work than the opposite) and that requires the support of the community.

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BOOK REVIEW

OPTICAL REMOTE SENSING – ADVANCES IN SIGNAL PROCESSING AND EXPLOITATION TECHNIQUES

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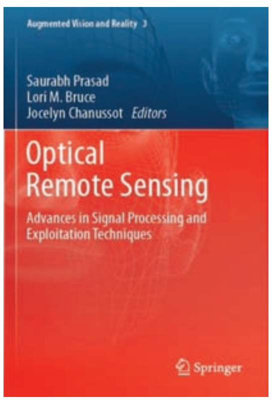

Edited by Saurabh Prasad,
Lori M. Bruce, Jocelyn Chanussot,
Springer Publishing Company,
Berlin, March 2011.
(ISBN: 978-3-642-14211-6)

This book is composed of contributions that address many of the contemporary problems faced when processing hyperspectral image data. As expected, there are chapters focussed on thematic mapping and classification, spectral un-mixing, morphology and compression, about which more is said below, but the really important inclusions are treatments of visualisation and display of hyperspectral data sets in Chapters 5 and 6; the latter is especially interesting in its treatment for visualising end members, while Chapter 5 provides a good overview of the field generally. Material on visualisation does not regularly feature in research overview publications, so it is good to see the importance placed on it by the editors through its inclusion.

The first chapter provides a comprehensive overview of the state of the art in hyperspectral image handling and processing, essentially setting the stage for the remaining coverage and situating each of the chapters in the context of the chain from signal acquisition to image product. Chapters 2, 3 and 4 explore the important topic of compression; Chapter 3 in particular provides a well reasoned argument in favour of compressive random projections and compressive sensing, while Chapter 4 argues that it makes sense to embed some processing at the point of data capture when using hyperspectral data. That will be essential when handling the enormous data volumes needing to be processed when image data is recorded by swarms of many smaller, cooperating satellites, that will undoubtedly need to communicate among each other during the data capture process. Chapter 2 provides an extensive review of techniques for compression but is short on actual descriptions of the techniques themselves, which limits its value.

Chapters 7, 9, 10, 11 and 14 are all concerned with classification in one way or another, and they are very different from each other; somewhat surprisingly, there is no chapter summarising the state of play in classification generally. The chapters included range over methods that sub-divide the hyperspectral domain to render the classification task more tractable (Chapter 7), the use of sets of classifiers to tackle thematic mapping tasks (Chapter 9), the application of non-linear dimensionality reduction procedures (Chapter 11) and the effect that spatial enhancement has on the recognition of class structure in imagery (Chapter 14). The level of mathematical and notational treatment varies across these chapters, from the straightforward through to that used in Chapter 11 which will challenge the earth scientist interested in the latest results. The same is true of Chapter 10, which reviews the application of kernel methods in remote sensing image processing and analysis. Again its level of mathematical sophistication will exercise the mathematical expertise of many readers, but it is one of the most important chapters of the book. Although it includes a significant component of well-known book work, this overview will be important to anyone interested in the state of kernel based methods in image analysis.

Along with Chapter 10, two others stand out as being more important than the rest in the topics they address, the manner in which they are written, and the coverage they provide. Chapter 8 is an excellent review of research in morphological processing, and its importance in the geometric analysis of high spatial resolution image data. Again, the notational context requires patience on the part of the reader but the coverage goes from introductory to recent results. Chapter 9 is devoted to the spectral un-mixing problem with hyperspectral data, covering both linear and non-linear methods. It is very well written, makes very good use of examples and will be an important reference work for those working on un-mixing problems.

Chapter 13 looks at the effect of registration errors on the accuracy of change detection using very high spatial resolution imagery. It commences with an assertion that currently available change detection methods are inadequate with high resolution data, without justification. Nevertheless, the content is important and the tools for assessing the impact of registration errors are interesting. The impact that spatial enhancement of hyperspectral imagery, similar in principle to pan-sharpening, has on the definition of spectral classes is the focus of Chap 14. While interesting and comprehensive, a stronger case could have been made as to why that is important. Chapter 15 is little more than a suggested methodology for assessing seismic vulnerability using optical and SAR data. The assessment of SAR is simplistic and no results are presented. It is surprising, particularly given the overview of Chapter 1, that no mention is made of lidar as a viable alternative to SAR for building height determination.

One of the problems with new research results in remote sensing is the increasing sophistication of the analytical procedures and concepts. That is to be expected; nevertheless, to make the technology widely usable researchers have to reach out to the community with terminology and descriptions that place new material within the grasp of the users, otherwise key results might stay in the laboratory. Such a high analytical level is a characteristic of many of the theoretical chapters of this book, since it is a treatment in general for the research and not the user community.

John Richards

John graduated from the University of New South Wales with the degrees of Bachelor of Engineering (Hons 1) and Doctor of Philosophy, both in Electrical Engineering. He is a Fellow of the Australian Academy of Technological Sciences and Engineering, a Fellow of the Institution of Engineers Australia and a Life Fellow of the Institute of Electrical and Electronics Engineers, NY.

John Richards is Master of University House at the Australian National University. He was formerly Deputy Vice-Chancellor and Vice President of the ANU, and Dean of the College of Engineering and Computer Science.

He worked previously at the University College, the University of New South Wales, Australian Defence Force Academy, where he served as Rector, Deputy Rector and Head of the School of Electrical Engineering.

In the early 1980s he was foundation Director of the Centre for Remote Sensing at the University of New South Wales, a position he held concurrently with a post in Electrical Engineering. He has held sabbatical positions at Purdue University, the University of California, Santa Barbara and the University of Cambridge.

John is an Emeritus Professor of both the Australian National University and the University of New South Wales and is a Visiting Professor at the Harbin Institute of Technology, China.

He received the Australian Centenary of Federation Medal and, in 2009, was made a Member in the Order of Australia for service to electrical engineering, professional associations and space science.

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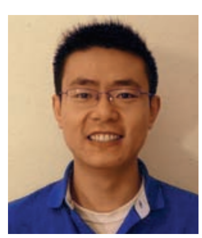

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2011 JOINT URBAN REMOTE SENSING EVENT (2011 JURSE)

Following the traditional schedule, the 2011 Joint Urban Remote Sensing event was held in Munich, Germany, on April 10–13, 2011. The conference was hosted by the Technical University of Munich and gathered people involved in research on the topic of urban remote sensing coming from 28 countries in 5 continents. The conference attendance was around 200 people, in line with past editions of the same event, showing that a strong community is backing the event, as also shown by the 44 professionals from academia, research centres and companies involved in the Technical Committee.

The venue of the conference and the historical area surrounding it, full with museums, offered an interesting contrast with the 2009 venue, Shanghai. It also stressed the challenges coming from the study with remote sensors different urban areas in the world, and importance of adapting any technique to the local and regional context. As opposite to the differences in the urban structure, the conference organization proved as excellent as it was in Shanghai, with accurate preparation and management of the sessions and a perfect choice of the social events.

Technical co-sponsorship for the conference was granted by the usual number of societies representing all the different scientific actors in the urban remote sensing research field: the Geoscience and Remote Sensing Society of the IEEE, three ISPRS Working Groups, ASPRS, EARSeL URSI Commission F and ICA. Moreover, EuroSDR (spatial Data Research) and DGPF (Deutsche Gesellschaft für Proteomforschung) was involved, and the European Space Agency (ESA) provided a grant that the Conference Chairs decided to use for the student Prize competition. Specifically, 10 papers by students from all over the world were selected, an their author invited at no fee and with lodging expensed covered to attend the conference and a Student Special Session, in two parts.

The number of papers submitted required a huge effort from the Conference Chairs to select the 10 best papers and an even greater effort to rank them after the presentation. Eventually, the paper by Thoreau Rory Tooke (the University of British Columbia, Australia) was awarded the first prize, with Diego Reale (CNR-IREA, Italy) ranking second and Y. Wang (DLR, Germany) third.

As for the technical program, the major change introduced this year was the full paper submission, as opposite to the abstract submission accepted until 2009. This choice, although possibly caused a reduction of the papers submitted, was meant to improve the quality of the workshop, allowing the Technical Committee a more accurate evaluation of the authors' proposals. Eventually, 70 papers were accepted for oral presentation, and other 47 more for the interactive session. The former ones were organized in two parallel oral sessions, while the poster display was organized in the early afternoon of one of the days, before a round of oral sessions, to encourage everyone to attend, and this choice proved to be correct and fruitful: we'll follow this path in next editions!

Three Special Sessions with invited talks were organized by researchers well-known in their own specific fields, including a Session on the Urbanization project within the Dragon II program, sponsored by ESA and the Chinese Ministry of Science

and Technology. Moreover, following the tradition to highlight new ideas in urban remote sensing and invite people from different realms using urban remote sensing data in their specific field of operation, even this year two keynotes speakers were invited. Prof. Jon. A. Benediktsson from the University of Iceland, current President of GRSS, provided an interesting and very detailed analysis of current research trends in mathematical morphology applied to remotely sensed data, while Prof. Rumor, current President of the Urban Data Management Society (UDMS), described the activities and aims of UDMS and suggested paths for useful collaborations between the people attending the conference and this society.

As mentioned before, social events at the 2011 JURSE were extremely well organized, from the icebreaker to the social dinner, preceded by a walking tour of the area between the conference and the dinner venue with detailed historical descriptions by the local Organizing Committee. Munich did not disappointed anyone hoping for a good beer, and the social dinner, including the award ceremony for the Student Paper prize, featured a group of alpine horns' players who won't be easily forgotten.

In the spirit to move the event outside Europe every other edition, the 2013 joint event will be hosted by the Instituto Nacional de Pesquisas Espaciai (INPE) and Pontificia Universitade Catolica de Rio de Janeiro (PUC-Rio) and the venue will be Sao Paulo, in Brazil. Sao Paulo is one of the South American mega cities, affected by specific problems in managing connected urban issues (e.g., air pollution, heavy traffic, …), and the expectations for the 2013 JURSE is already high, given the excellent record of conferences already organized by the local team.

São Paulo

JURSE 2013

Finally, and following the tradition of the Special Issues of the IEEE Journal on Selected Topics in Applications of Remote Sensing (the one about JURSE2009 was published in March 2011), a new call for paper was already distributed to the conference attendees. The Guest Editors of this issue will be the four Conference Co-Chairs: the "historical trio" of Paolo Gamba, Deria Maktav and Carsten Juergens, and the local organizer, Prof. Uwe Stilla. The deadline is set to October 31st, 2011, and the issue topic reflects the changes of the last few years while keeping a connection with the tradition of the events: "Human settlement monitoring using multiple EO data".

Paolo Gamba
JURSE 2011 General Co-Chair

TECHNICAL COMMITTEES CORNER

DATA ARCHIVING AND DISTRIBUTION (DAD) TECHNICAL COMMITTEE (TC)

H. K. "Rama" Ramapriyan (Chair), NASA Goddard Space Flight Center

Gilbert Rochon (Co-Chair), Tuskegee University

1. Introduction

The Data Archiving and Distribution Technical Committee (DAD-TC) is a group of individuals from many countries and organizations with common interests in diverse aspects of managing remotely sensed data throughout their life cycle. It has been in existence since 1994 (originally called the Data Standardization and Distribution Technical Committee) and known by its present name since 2001. Its mission is:

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

Currently, the DAD TC has 54 members and collaborators from 9 different countries: Canada, China, Germany, Italy, Japan, South Africa, Switzerland, United Kingdom and the United States of America. The main activities of the DAD TC are:

- Organizing and conducting special sessions at the annual IGARSS meetings
- Publishing special issues of TGARS and JSTARS
- Developing and maintaining GEOSS Component and Service Registry
- Maintaining a set of research priorities in technologies for data archiving and distribution
- Participating and /or leading standards efforts

Each of these activities will be briefly discussed below.

2. IGARSS Special Sessions

Since 2002, the DAD TC has held special sessions on various aspects of archiving, distribution and management of Earth remote sensing data. Typically, these are invited sessions with oral presentations from experts in the field and include a few selected papers from general submissions. The titles of the sessions are shown here, including the two sessions planned for IGARSS 2011:

Year	Special Session Titles
2002	Data Services and Tools
2003	Best Practices for Geospatial Data Management
2004	Image Information Mining (I2M) and Intelligent Data Understanding (IDU)
2005	Data Mining and Image Information Mining
2006	Developing, deploying, and operating standard-based data systems Geospatial Knowledge Systems
2007	Measurement-based Data Systems Data Search, Access, Distribution and Specialized Services
2008	Earth Observation Sensor Web Improving Access to Earth Science Data – New Tools and Services
2009	Earth Observation Sensor Web: Technologies, Solutions, and Perspectives Advances in Data Systems for Future Missions and Earth Science Research
2010	Data System Technologies for Improving Data Access and Usability – Challenges and Solutions International Open Standards for Geosciences – Standards Development
2011	International Developments and Collaborations in Earth Observation Data Systems Provenance in Geoscience Data

Presentations from some of these special sessions are available at the DAD TC web site: http://www.grss-ieee.org/community/technical-committees/data-archival-distribution/important-links/.

3. Transactions Special Issues and Books

In recent years, the DAD TC has been active in proposing and publishing special issues of TGARS and JSTARS, as well as one book. A special issue of TGARS on Data Archiving and Distribution was published in January 2009 [1]. To the best of our knowledge, this issue is the first of its kind. It represented the "coming of age" of the technical areas of data systems and geoscience informatics. The scope of this issue is considerably broader than data archiving and distribution, including data access, interoperability, and specialized services such as visualization. Contributing to the high interest in this area are a "data-rich" environment that has benefited Earth science researchers and applications' practitioners over the last decade, advances in the ever-expanding capabilities of the World Wide Web, and

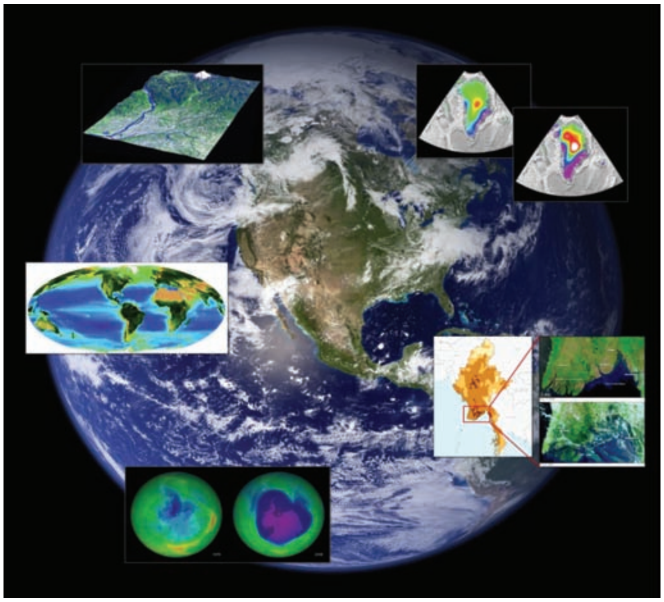

Figure 1. DAD TC is concerned about all aspects of managing remotely sensed (and other Earth science related) data. Shown here are images derived from various such data sources. Background image: Blue Marble, Courtesy: earthobservatory.nasa.gov Clockwise from top left: Portland, OR and Mt. Hood, ASTER Images draped on ASTER Global Digital Elevation Model, Courtesy: NASA LPDAAC Changes in Greenland's Ice Mass as measured by GRACE, upper left 2005, lower right 2008, Courtesy: NASA JPL Gridded Population of the World map of Myanmar, Courtesy: sedac.ciesin.columbia.edu Myanmar before and after flooding from Cyclone Nargis as seen by Terra MODIS, Courtesy: earthobservatory.nasa.gov Antarctic Ozone Hole: 1979–2008 TOMS, Courtesy: earthobservatory.nasa.gov SeaWiFS Global Biosphere, September 1997–August 1998, Courtesy: oceancolor.gsfc.nasa.gov

enabling technologies such as mass storage, high-speed computation, database management, data mining, information extraction, evolving standards, middleware for data access, and Web services to facilitate collaborative science. The 13 papers in this Special Issue cover broad data system capabilities and their development and evolution, processing, archiving, distribution, search and access, as well as long-term preservation.

A special issue of the JSTARS on Earth Sensor Web was published in December 2010 [2]. A consensus definition of a sensor web is "a coordinated observation infrastructure composed of a distributed collection of resources—e.g., sensors, platforms, models, computing facilities, communications infrastructure—that can collectively behave as a single, autonomous, taskable, dynamically adaptive and reconfigurable observing system that provides raw and processed data, along with associated metadata, via a set of standards-based service-oriented interfaces". This issue has 14 papers covering recent technology advances in Sensor Webs, Sensor Web concepts, system architecture, and integration, and Sensor Web applications.

A book titled *Standard-Based Data and Information Systems for Earth Observations* [3] was published in 2009 by Springer. This book has 13 chapters, largely based on papers presented at the DAD TC special sessions at IGARSS 2006. The topics covered by the book include new or updated standards, the development of standards-based data systems, data access and discovery services, new data capabilities and sources available through standards-based data systems, data systems architecture, lessons learned from development, deployment, and operation of standards-based data systems, and other related subjects. The book also addresses new technologies for Service Oriented Architecture-based geospatial knowledge systems, including knowledge discovery algorithms, distributed image information mining, architectures and standards, knowledge system prototypes, geospatial knowledge representation, and geospatial semantic Web.

4. GEOSS Support

The DAD TC has been supporting the Global Earth Observation System of Systems (GEOSS) effort in collaboration with other GEOSS participating organizations. The DAD TC has been involved, through its members, in providing data and services to a number of GEOSS Architecture demonstrations organized by the IEEE and the Open Geospatial Consortium (OGC), including at IGARSS 2005 in Seoul, FIEOS 2006 in Beijing, IGARSS 2006 in Denver, and GSDI 2006 in Chile. In addition, DAD TC members have been involved in designing, developing, and operating the GEOSS component and service registry (CSR) by working with GEOSS Architecture Task AR-07-01 team and the Center for Spatial Information Science and Systems (CSISS), George Mason University. The registry manages the registration and discovery of GEOSS-wide resources. In May 2009, a process was established for approval of CSR entries. Each entry is manually approved to ensure that it meets certain quality criteria. Only the approved records are listed on the holding page, are searchable through the public non-secure search interface, and are viewable through the API interface. As of this writing, 283 components and 170 services have been registered (see http://geossregistries.info).

5. Research Priorities

Significant progress has been made in archiving, distribution, access, interoperability, visualization and other aspects of data and information systems for remotely sensed Earth science data over the last decade. In this context, the DAD TC community has identified a few key questions to be addressed by research and development activities in the near future. These are identified below in four major areas: Archiving and Preservation, System Interoperability, Access, and On-Line Services and Enabling Analysis. These are extracted from a paper presented at IGARSS 2010 [4].

5.1. Archiving and Preservation

- *Data Readability and Integrity:* How long can current data formats be expected to survive, and will they be readable after 2 or 3 updated versions of the format have been released or after other formats have superseded them in popularity? How can we insure ensure that critical data survive this process of technological evolution with integrity?
- *Data Availability:* How can we insure ensure that data remain accessible for reasonable periods of time, irrespective of what happens to the site archiving them? How long a time period should be considered minimal for public access?
- *Data Identity:* How do we know that two files contain the same data even if the formats are different? That is, how do we ensure that two data sets are "scientifically identical"? How do we find the data used in a particular publication? How can we uniquely and unambiguously identify a particular piece of data no matter which copy a user has? How can we provide online citation technology in a consistent and interoperable way?
- *Provenance:* How do we define the appropriate levels of provenance information and ensure that they are included along with data during production and in the archive?
- *Data Encoding and Compression:* How can we encode data in an interoperable, flexible, scalable, efficient way that preserves the likelihood that the data will be understandable decades into the future? This includes data compression issues for network (Web) exchange.
- *Validation of Data Properties:* What are the appropriate methods and frequencies with which data object properties should be validated in an archiving system that is subject to hardware and software failures, operational errors, natural disasters, or malicious attacks?
- *Transparent Technology Refreshment:* What techniques should be used to ensure "transparent technology refreshment", i.e., upgrading to new generations of hardware and software while maintaining high levels of operational availability, addressing the dynamic and evolving archive environment, and maximizing the application of limited resources?

5.2. System Interoperability

- *Data Discovery:* How can we provide online discovery for disparate (i.e. heterogeneous and distributed) datasets?
- *Hardware Technology Trends:* What are the continuing trends of technology evolution and cost (a la Moore's law) in processing, storage and network bandwidth? What are their implications on overall end-to-end systems' architecture?
- *Standardization:* Are current standards adequate or are new standards needed to eliminate or reduce impacts of heterogeneity? Standardization is essential for interoperability and information heterogeneity management. It also facilitates evolvability and helps reduce costs. Standardization efforts apply to:
  - people, primarily in the form of terminology standards
  - information, primarily in the form of structural and semantic representation standards
  - systems, primarily in the form of interface and communication standards.
- *Conceptual Composability (Systems of Systems):* How do we introduce the necessary "interoperability arrangements" necessary to implement complex Systems of Systems collecting task-oriented, autonomous systems that pool their resources together to obtain a more complex, 'meta-system' (e.g. GEOSS) ?

5.3. Access

- *Security:* How do we strike a balance between open access to data and the need to protect data from malicious or inadvertent corruption? How do service providers protect their systems from "denial of service" attacks and other improper uses of the data and services?
- *Standards:* What standards should be developed or adopted to facilitate access to data? Which basic processing functionalities should be included (e.g. domain/co-domain subsetting, transformations, etc.)?

5.4. On-Line Services and Enabling Analysis

- *Data Visualization and Analysis:* How can we provide online visualization and analysis tools that can assist users in identifying meaningful data subsets within large sets?
- *Data, Algorithms, and Services:* How do we associate data with the services that act on them and with the algorithms that create them? How do we make distributed data and associated services discoverable without requiring users to learn multiple search tools? In order to support the data and information needs of the application communities is it possible to determine what products have the most socio/economic value and what algorithms are needed in order to produce them? Can such lists be updated dynamically as sensors and applications continue to evolve? For example, how best can we make the user community aware that digital elevation maps (DEMs) can be produced accurately from Synthetic Aperture Radar (SAR) interferometry, or that sea ice surface temperatures are now available from infrared (IR) channels, or that a new vegetation index has been produced from Moderate Resolution Imaging Spectro-radiometer (MODIS) data?
- *Data Evaluation:* How do we evaluate datasets, including their quality, content, and constraints? Data quality issues are especially important in the present Web era where global viewers help non-expert users fuse and visualize heterogeneous and distributed datasets, potentially in scientifically erroneous ways due to a substantial lack of information about data uncertainty and error propagation.

- *Standards:* How will uncertainty and error propagation description and management affect existing standards?

6. Standards

Many engineers and scientists in geosciences and remote sensing are also involved in standards activities. The standards of primary concern to the DAD TC are those that pertain to data and information. International standards on data and metadata facilitate interoperability among different data systems and broader usage of data by scientists for advancement of knowledge. Members of DAD TC are actively leading and/or participating in various standards activities. These include: The IEEE Committee on Earth Observation (ICEO) Standards Working Group (ISWG), the Open Geospatial Consortium, and the International Organization for Standardization (ISO). Members of the DAD TC organized two special sessions at IGARSS 2010 with the theme "International Open Standards for Geosciences" [5]. Members of DAD TC maintain a liaison relationship with the ISO Technical Committee (TC 211) on Geographic Information. Siri Jodha Khalsa has served since 2004 as GRSS liaison to TC 211. Liping Di, former chair of DAD TC, has been very active with TC 211 and is the liaison from TC 211 to GRSS. George Percival and Paul Smits have also had long-term involvement with TC 211. The ISO standards currently being worked on actively include: ISO 19159 (Calibration and validation of remote sensing imagery sensors and data), ISO 19130 (Imagery sensor models for geo-positioning—Part 2: SAR, InSAR, Lidar and Sonar), ISO 19115 (Metadata—Part 1: Fundamentals), ISO 19157 (Data Quality), and ISO/TS 19150 (Ontology). Also, several members of the DAD TC in the United States are participating in the "Data Stewardship and Preservation Cluster" of the Federation of Earth Science Information Partners and are leading an effort to define a Provenance and Context Contents Standard for data supporting global change research. The goal of this standard is to enable new missions to plan for preservation of required content. Also assessing compliance to the standard would help determine the utility of datasets for long-term climate studies.

7. Summary

The Data Archiving and Distribution Technical Committee (DAD-TC) is a group of 54 members and collaborators from 9 different countries with common interests in diverse aspects of managing remotely sensed data. The main activities of the DAD TC are:

- Organizing and conducting special sessions at the annual IGARSS meetings
- Publishing special issues of TGARS and JSTARS
- Developing and maintaining GEOSS Component and Service Registry
- Maintaining a set of research priorities in technologies for data archiving and distribution
- Participating and /or leading standards efforts

Since 2002, the DAD TC has held special sessions on various aspects of archiving, distribution and management of Earth remote sensing data. Presentations from some of these special sessions are available at the DAD TC web site: http://www.grss-ieee.org/community/technical-committees/data-archival-distribution/important-links/. During 2009 and 2010, DAD TC published a special issue of TGARS, a special issue of JSTARS and a book titled "Standard-Based Data and Information Systems for Earth Observations". The DAD TC has been supporting the Global Earth Observation System of Systems (GEOSS) effort in collaboration with other GEOSS participating organizations. Members of DAD TC have supported several GEOSS workshops. They have developed and are maintaining a Component and Services Registry where, as of this writing, 283 components and 170 services have been registered. Considering the significant progress made in archiving, distribution, access, interoperability, visualization and other aspects of data and information systems for remotely sensed Earth science data over the last decade, the DAD TC community has identified a few key questions to be addressed by research and development activities in the near future. The questions are identified in four major areas: Archiving and Preservation, System Interoperability, Access, as well as On-Line Services and Enabling Analysis. In addition, members of DAD TC are involved in international standards activities that pertain to data and information.

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CHAPTERS CORNER

GRSS DISTINGUISHED SPEAKERS PROGRAM

David M. Le Vine, NASA Goddard Space Flight Center, Maryland, USA
Distinguished Speakers Committee Chair

The purpose of the Distinguished Speakers program is to provide our members with an opportunity to interact with experts in areas of interest to the geoscience and remote sensing community. It is an opportunity to learn about some of the exciting work being done in our discipline and to meet some of the prominent members of our Society. This is a resource to support our Chapters.

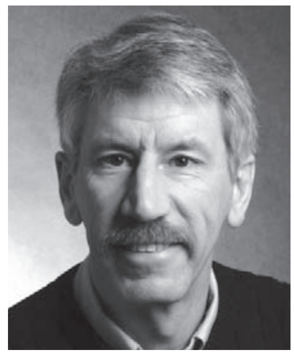
We have recently revised the process and increased the resources available to support speakers. The new procedures and list of speakers is available on the GRSS website (www.grss-ieee.org then click on "Education" and "Distinguished Speakers"). The initiative to take advantage of the distinguished speakers rests with the Chapters. The Chapters must contact the speaker and arrange for the visit, but sufficient resources have been allocated so that the Chapter should be able to do this with little expense. The GRSS will provide $1250 per domestic trip (within the speaker's home continent) and $2500 for an intercontinental trip. The number of funded trips per speaker is limited (2 domestic and 1intercontinental) so it is probably a good idea to book your speaker soon. Each Chapter can invite a maximum of two speakers per year.

The speakers are individuals of outstanding accomplishment in their field. We have tried to choose individuals whose fields of interest span the broad area of interest to the GRSS community. The list is not static and is expected to change. The goal is to have speakers and topics that interested you. Your suggestions of either topics or speakers or both would be greatly appreciated. Proposals for speakers not on the current list will also be considered with sufficient justification.

Please send you suggestions or questions to the Distinguished Speakers Program Chair, David Le Vine at levine@ieee.org.

Distinguished Speakers for 2011

1) Dr. Robert Bindschadler: Emeritus Scientist, Hydrospheric and Biospheric Sciences Laboratory, Code 64, NASA Goddard Space Flight Center, Greenbelt, MD 2077, Email: Robert.A.Bindschadler@nasa.gov



Dr. Robert Bindschadler's career spanned more than 30 years at NASA where he retired in 200 as the Chief Scientist of NASA's Hydrospheric and Biospheric Sciences Laboratory and a Senior Fellow of the Goddard Space Flight Center. He is a Fellow of the American Geophysical Union and a past President of the International Glaciological Society and currently a Senior Research Scientist at the University of Maryland Baltimore County. He maintains an active interest in glaciers and ice sheets and has led 5 Antarctic field expeditions to study dynamics of the West Antarctic ice sheet. During his NASA career, he has developed numerous unique applications of remote sensing data for glaciological research including measuring ice velocity and elevation using both visible and radar imagery, monitoring melt of the ice sheet by microwave emissions, and detecting changes in ice-sheet volume by repeat space-borne radar altimetry. He has testified before Congress, briefed the U.S. Vice President, published over 40 scientific papers, including numerous review articles and is often quoted commenting on glaciological impacts of the climate on the world's ice sheets and glaciers.

Talk Abstract – Waking Giants: Ice Sheets in a Warming World

The great ice sheets of Greenland and Antarctica are shrinking faster and faster, increasing the rate of sea level rise. Observations of this accelerating ice loss have surprised the experts and confounded the predictive models that policy makers might rely on to take action. The distant future is easy to forecast—less ice on Earth—one million years of paleoclimate data say so, but more detail is needed. Direct field studies have identified a number of causes for the sudden awakening of the ice sheets. Whether it is ponded meltwater that destroys thick floating ice shelves, flowing meltwater that cascades through nearly a mile of ice to lubricate the base of the ice sheet, or warmer water circulating underneath floating ice shelves to thin them allowing a faster release of grounded ice, water is the primary agent of change. In a warmer world, ice sheets will be forced to respond to more water. The analogue of tidewater glacier retreat casts a disheartening picture that continued ice sheet mass loss may well be irreversible.

2) Dr. David Goodenough: 3355 Haida Drive, Victoria, B.C. V9C 3P2, CANADA, E-mail: dgoodeno@nrcan.gc.ca

David Goodenough has been a senior Research Scientist at Pacific Forestry Centre in Victoria, BC, of the Canadian Forest Service, Natural Resources Canada. He is also an Adjunct Professor of Computer Science at the University of Victoria where he has graduate students and is a NSERC recipient. He is a Fellow of the IEEE (1997). He is a recipient of the IEEE Third Millennium Medal (2000). He was President of the IEEE Geoscience and Remote Sensing Society (1992–1993) and served as Past-President (1994–1996). Dr. Goodenough holds the following degrees: Ph.D. and M.Sc. (University of Toronto), M.Sc. and B.Sc. (University of British Columbia). He was an Assistant Professor of Astronomy at Wheaton College in Norton, MA (1970–1973). He was an Adjunct Professor of Electrical Engineering at the University of Ottawa (1979–1996). Dr. Goodenough worked at the Canada Centre for Remote Sensing (1973–99), where he was a Chief Research Scientist and Head of the Knowledge-Based Methods and Systems Section. He has published extensively (>200 papers). He has received the following awards: Government of Canada's Award of Excellence; the IEEE GRS-S Distinguished Achievement Award; the Canadian Remote Sensing Society's Gold Medal Award; the IEEE GRSS Outstanding Service Award; a Natural Resources Canada Departmental Merit Award; an Energy, Mines, and Resources Merit Award; and NASA Group Achievement Awards. Dr. Goodenough is Principal Investigator of a Radarsat-2 Forest Applications Project, a Hyperspectral Forest Applications Project, and a Co-I of a Scientific GRID Computing and Data Project for producing Above-Ground Forest Carbon Maps. Dr. Goodenough was Principal Investigator (PI) of the NASA project, Evaluation and Validation of EO- for Sustainable Development (EVEOSD) of forests. He is also PI of a CHRIS project, EVC, with the European Space Agency. Dr. Goodenough was the PI of the System of Experts for Intelligent Data Management (SEIDAM) Project with NASA. He was PI of a project for monitoring Canada's above ground carbon in its forests. He is a member of a USAF / DND hyperspectral team for a new hyperspectral sensor, ARTEMIS. Dr. Goodenough's current research interests focus on methods and algorithms for forest information from hyperspectral and polarimetric radar systems in order to create geospatial products for forest species, forest health, and forest carbon. He has provided consultation on remote sensing methods and systems for civilian and defense applications. Dr. Goodenough has participated in national and international large satellite missions, serving on Phase A teams, User and Science Teams, and Evaluation Teams.

Talk Abstract – Methods and Systems for Applications

In order to monitor the resources and environment of the planet, it is necessary to use remote sensing from multiple sensors and integrate these data with historical information contained within geographical information systems (GIS). Multiple sensors are required to identify attributes of interest. In forestry, resource managers want to know the amount of the resource by species, area, timber volume, etc., the spatial distribution, the health (chemistry) of the forests, and the temporal changes of the resource, both past and predicted for the future. The technologies of the IEEE Geoscience and Remote Sensing Society are used to create information systems to support resource and environmental management. In this presentation we describe hyperspectral and radar methods and systems to obtain valuable forest information, such as chemistry, above-ground carbon, species, and biomass. Models of forests are used to predict remote sensing results. The inversion of these results can lead to the estimation of forest parameters. National and global monitoring requires systems for distributed data management. We have created a system (www.saforah.org) using GRID architecture, optical light paths, and a petabyte data store at the University of Victoria. SAFORAH serves out to the public and research community remotely sensed data of Canada and forest information products for land cover, biomass, and change. Hyperspectral sensing is used to obtain species distribution and forest chemistry. Examples of this work for forest applications and the generation of Kyoto Protocol products are presented.

3) Professor Ya-Qiu Jin: Fudan University, 220 Handan Road, Shanghai 200433, China, Email: yqjin@fudan.edu.cn

Ya-Qiu Jin graduated from Peking University, Beijing, China in 1970, and received the M.S., E.E., and Ph.D. degrees from the Massachusetts Institute of Technology, Cambridge, USA in 1982, 1983 and 1985, respectively. All the degrees are from electrical engineering. He was a Research Scientist with the Atmospheric and Environmental Research, Inc., Cambridge MA, USA (1985); a Research Associate with the City University of New York (1986–1987); a Visiting Professor with the

University of York, U.K. (1993–1994) sponsored by the U.K. Royal Society; a Visiting Professor with the City University of Hong Kong (2000); and a Visiting Professor with Tohoku University, Japan (2005). He held the Senior Research Associateship at NOAA/NESDIS awarded by the USA National Research Council (1996). He is currently a Chair Professor of Fudan University, Shanghai, China, and the founder Director of the Key Laboratory of Wave Scattering and Remote Sensing Information (Ministry of Education). He has been appointed as the Principal Scientist for the China State Key Basic Research Project (2001–2006) by the Ministry of National Science and Technology of China to lead the remote sensing program in China. He has published more than 620 papers in refereed journals and conference proceedings and eleven books, three of which are in English [*Electromagnetic Scattering Modeling for Quantitative Remote Sensing* (World Scientific, 994), *Information of Electromagnetic Scattering and Radiative Transfer in Natural Media* (Science Press, 2000), *Theory and Approach for Information Retrieval from Electromagnetic Scattering and Remote Sensing* (Springer, 2005)]. He is co-editors of *Selected Papers on Chinese Chang'E-1 Microwave Lunar Exploration* (Science Press, 2010) and SPIE Volume 3503 *Microwave Remote Sensing of the Atmosphere and Environment*, and the book *Wave Propagation, Scattering and Emission in Complex Media* (World Scientific and Science Press, 2004). His main research interests include scattering and radiative transfer in complex natural media, microwave remote sensing, as well as theoretical modeling, information retrieval and applications in atmosphere, ocean, and Earth surfaces, and computational electromagnetics. Dr. Jin is the member of IEEE GRSS AdCom, Chair of IEEE fellow Evaluation Committee (GRSS), the Associate Editor of IEEE Transactions on Geoscience and Remote Sensing (TGRS), and IEEE GRSS Distinguished Speaker, Co-Chair of Technical Committee of IGARSS2011, and Chairmen of several international conferences. He is the Founder and Chairman of IEEE GRSS Beijing Chapter (1998–2003) and received the appreciation for his notable service and contributions toward the advancement of IEEE professions from IEEE GRSS. He received IEEE GRSS Education Award in 200, the China National Science Prize in 1993, the first-grade MoE Science Prizes in 1992, 1996 and 2009, and the first-grade Guang-Hua Science Prize in 1993 among many other prizes.

Talk Abstract – Modeling, simulation, inversion and Chang E data validation for microwave observation in China's lunar project

In China's first lunar exploration project, Chang'E-1(CE-1), a multi-channel microwave radiometer in passive microwave remote sensing, was first aboard the satellite, with the purpose of measuring microwave brightness temperature from lunar surface and surveying the global distribution of lunar regolith layer thickness. In this lecture, the multi-layered model of lunar surface media is presented, and numerical simulations of multi-channel brightness temperature (Tb) from global lunar surface are obtained. It is applied to study of retrieving the regolith layer thickness and evaluation of global distribution of ^{3}He content in regolith media. Multi-channel Tb measurements by CE- microwave radiometers are displayed, and applied to inversion of the regolith layer thickness, which are verified and validated by the Apollo *in situ* measurements. It is the first time to retrieve the regolith thickness and ^{3}He content using microwave remote sensing technology.

In active microwave remote sensing, based on the statistics of the lunar cratered terrain, e.g. population, dimension and shape of craters, the terrain feature of cratered lunar surface is numerically generated. Electromagnetic scattering is simulated, and SAR (synthetic aperture radar) image is then numerically generated, e.g. making use of the digital elevation and Clementine UVVIS data at Apollo 15 landing site as the ground truth, an SAR image at Apollo 15 landing site is simulated. Utilizing the nadir echoes time delay and intensity difference from the surface and subsurface, high frequency (HF) radar sounder is an effective tool for investigation of lunar subsurface structure in lunar exploration. Making use of rough surface scattering and ray tracing of geometric optics, a numerical simulation of radar echoes from lunar layering structures with surface feature, the topography of mare and highland surfaces is developed. Radar echoes and its range images are numerically simulated, and their dependence on the parameters of lunar layering interfaces are described.

4) Dr. Ricardo Lanari: IREA-CNR, via Diocleziano 328 8024 Napoli, Italy, E-mail: lanari.r@irea.cnr.it

Riccardo Lanari was born in Napoli, Italy, in 1964 and graduated in 1989, summa cum laude, in Electronic Engineering at the University of Napoli, Federico II. In the same year, following a short experience at ITALTEL SISTEMI SPA, he joined IRECE and after IREA, a Research Institute of CNR (the Italian National Council of Research), where he currently occupies the position of senior researcher. His main research activities are in the Synthetic Aperture Radar (SAR) data processing field as well as in SAR interferometry techniques; on this topic he holds two patents, has authored more than 60 international journal papers and, in 1999, the book entitled "Synthetic Aperture Radar Processing", written in collaboration with prof. Giorgio Franceschetti and edited by CRC-PRESS.

Riccardo Lanari has been a visiting scientist at different foreign research institutes, including the Institute of Space and Astronautical Science (ISAS), Japan (1993), the German Aerospace Research Establishment (DLR), Germany (1999 and 1994) and the Jet Propulsion Laboratory (JPL), USA (1997, 2004 and 2008), where he received a NASA recognition for the technical developments related to the SRTM mission. Riccardo Lanari is a senior member of the IEEE society and he has served as chairman and technical program committee member at several international conferences. Moreover, he acts as reviewer of several peer reviewed international journals. Riccardo Lanari has lectured in several national and foreign universities and research centers; he has been adjunct professor of Electrical Communication at the l'Università del Sannio (Benevento) from 2000 to 2003 and, from 2000 to 2008, lecturer of the SAR module course of the International Master in Airbone Photogrammetry and Remote Sensing, offered by the Institute of Geomatics in Barcelona (Spain).

Talk Abstract – Differential SAR Interferometry: basic principles, key applications and new advance

Differential SAR Interferometry (DInSAR) is a microwave imaging technique that permits to investigate earth surface deformation occurring in an area of interest with a centimetre (in some cases millimetre) accuracy. In particular, the DInSAR technique exploits the phase difference (interferogram) of temporally separated SAR images relative to the investigated zone and has already shown its capability in detecting surface deformation caused by different natural and anthropogenic phenomena. The aim of this talk is to introduce the basic concepts involved in the DInSAR technique, summarize the key applications of this method and present its new advance. In particular, a discussion on the rationale of the DInSAR approach will be given first, highlighting the key points and the main limitations. Several examples will be presented for underlining the capability of the technique to analyze the displacements caused by different phenomena such as volcano deformation, earthquakes and urban subsidence. Subsequently, the talk will be focused on the advanced DInSAR techniques allowing to analyze the temporal evolution of the detected displacements through the generation of deformation time-series computed from a data set of temporarily separated SAR images. Finally, the advance brought in by the new generation X-band spaceborne SAR sensors, characterized by higher spatial resolution and shorter revisit times with respect to the earlier C-band systems, will be discussed, emphasizing the new investigation possibilities for fast varying deformation phenomena.

5) Dr. Keith Raney: Principal Professional Staff, Applied Physics Laboratory, Laurel, MD, 20723, Email: Keith.Raney@jhuapl.edu

Dr. Raney received a BS (with honors) in physics from Harvard University (1960), a MSEE from Purdue University (1962), and a PhD in Computer Information and Control from the University of Michigan (1968). He contributed to the design of NASA's Venus radars Pioneer and Magellan, the ERS-SAR of the European Space Agency (ESA), and the Shuttle Imaging Radar SIR-C. While with the Canada Centre for Remote Sensing (1976–1994) Dr. Raney was scientific authority for the world's first digital processor for satellite SAR data, and responsible for the conceptual design of the RADARSAT synthetic aperture radar (SAR). These and other contributions in radar remote sensing systems, theory, and applications are documented in more than 350 professional publications. Dr. Raney was on NASA's Instrument Definition Teams for the Europa Orbiter and several Mars missions, the IDTs and Science Teams for Magellan and Pioneer Venus, and advisory teams for ESA's ERS radars. He was on the Science Advisory Group for ESA's CryoSat radar altimeter, whose design is based on his original concept. He holds several United States and international patents, and two patents on polarimetric radar architectures, including the conceptual design of the Mini-RF radars for which he was the radar architect. He served for more than 20 years as an Associate Editor (radar) for the IEEE Transactions on Geoscience and Remote Sensing, and was the Society's President for two terms (1988–9). He has served on numerous advisory committees for the Office of Naval Research, the U.S. National Academy of Sciences, Germany's Helmholtz Society, and the Danish Technical Research Council, among others. He is a Life Fellow of the IEEE, a Fellow of the Electromagnetics Academy, and an Associate Fellow of the Canadian Aeronautics and Space Institute. Dr. Raney is a recipient of numerous awards, including the 1999 Gold Medal of the Canadian Remote Sensing Society, the IEEE Geoscience and Remote Sensing Society Transactions Prize Paper for 1998, the IEEE Millennium Medal 2000, and the IEEE Dennis J. Picard Medal for radar technologies and applications for 2007.

Talk Abstract – Two Hybrid-Polarimetric Imaging Radars at the Moon: Their Design, Build, and Results

The two Mini-RF radars flown in near-polar lunar orbits (on Chandrayaan-1 and the Lunar Reconnaissance Orbiter) were the first of their kind, hybrid-polarimetric. This new paradigm transmits circular polarization, and receives coherently on orthogonal linear polarizations. The resulting data support calculation of the 2x2 covariance matrix of the backscattered field, from which follow the four Stokes parameters. These are the basis of science products from the observations, which include images that are traditional in radar astronomy, as well as polarimetric decompositions. The instruments each have mass less than 15 kg, antenna areas of about 1 m^2, and modest power and spacecraft accommodation requirements. Data quality and instrument characteristics suggest that hybrid polarity is highly desirable for future exploratory radar missions in the Solar system.

6) Dr. Werner Weisbeck: Institut fuer Hochfrequenztechnik und Elektronik, KIT-Karlsruhe Institute of Technology, Kaiserstrasse 12, Karlsruhe D 76131, GERMANY, E-mail: werner.wiesbeck@kit.edu

Werner Wiesbeck received the Dipl.-Ing. (M.S.E.E.) and the Dr.-Ing. (Ph.D.E.E.) degrees from the Technical University Munich in 1969 and 1972, respectively. From 1972 to 1983 he was with AEG-Telefunken in various positions including that of head of R&D of the Microwave Division in Flensburg and marketing director Receiver and Direction Finder Division, Ulm. During this period he had product responsibility for mm-wave radars, receivers, direction finders and electronic warfare systems. From 1983 to 2007 he was the Director of the Institut für Höchstfrequenztechnik und Elektronik (IHE) at the University of Karlsruhe (TH) and he is now Distinguished Scientist at the Karlsruhe Institute of Technology (KIT). Research topics include antennas, wave propagation, Radar, remote sensing, wireless communication and Ultra Wideband technologies. In 1989 and 1994, respectively, he spent a six months sabbatical at the Jet Propulsion Laboratory, Pasadena. He is a member of the IEEE GRSS AdCom (1992–2000), Chairman of the GRSS Awards Committee (1994–1998, 2002–present), Executive Vice President IEEE GRSS (1998–1999), President IEEE GRSS (2000–2001), Associate Editor IEEE-AP Transactions (1996–1999), past Treasurer of the IEEE German Section (1987–1996, 2003–2007). He has been General Chairman of the '88 Heinrich Hertz Centennial Symposium, the '93 Conference on Microwaves and Optics (MIOP '93), the Technical Chairman of International mm-Wave and Infrared Conference 2004, Chairman of the German Microwave Conference GeMIC 2006 and he has been a member of the scientific committees and TPCs of many conferences. For the Carl Cranz Series for Scientific Education he serves as a permanent lecturer for Radar systems engineering, wave propagation and mobile communication network planning. He is a member of an Advisory Committee of the EU - Joint Research Centre (Ispra/Italy), and he is an advisor to the German Research Council (DFG), to the Federal German Ministry for Research (BMBF) and to industry in Germany. He is the recipient of a number of awards, lately the IEEE Millennium Award, the IEEE GRS Distinguished Achievement Award, the Honorary Doctorate (Dr. h.c.) from the University Budapest/Hungary, the Honorary Doctorate (Dr.-Ing. E.h.) from the University Duisburg/Germany and the IEEE Electromagnetics Award 2008. He is a Fellow of IEEE, an Honorary Life Member of IEEE GRSS, a Member of the IEEE Fellow Cmte, a Member of the Heidelberger Academy of Sciences and Humanities and a Member of the German Academy of Engineering and Technology (acatech).

Talk Abstract – Digital Beam-Forming in Remote Sensing

The invention of the Synthetic Aperture Radar (SAR) principle dates back to the early 1950s. The basic idea is to filter targets in a side looking radar according to their Doppler history in azimuth and by pulse or FM modulation compression in range. Since this time SAR systems have been, from a technical point of view, considerably refined to the state of the art where resolution and accuracy are close to the theoretical limits. The best innovations have been reached in polarimetry and interferometry. Nevertheless, the principles are still the same: The SAR is a side-looking radar where resolution is achieved in range by bandwidth and in azimuth by Doppler processing. The beam-forming concepts for coverage are still the same: dish antennas (scanned or fixed), antenna arrays (phased or fixed) or switchable antenna systems. All these have the drawback that the coverage defines the synthetic aperture length and by this the azimuth resolution or for scanned beams the loss of coverage has to be taken into account. These draw backs can be overcome by Digital Beam-Forming. Significant advantages result by this. In its simplest form the transmit antenna illuminates a usually larger footprint, as do the multiple receive antennas. The beam-forming is accomplished in a digital process. Multiple receive beams may be processed simultaneously. The RF losses can significantly be reduced, allowing lower gain for the antennas, and thus larger footprints. In addition Digital beam-forming can handle coded signals, like OFDM, for range and azimuth compression. This talk will present the principles and applications and latest results of Digital Beam-Forming in Remote Sensing.

UNIVERSITY PROFILE

MICROWAVE REMOTE SENSING RESEARCH AND EDUCATION AT CENTER FOR ENVIRONMENTAL REMOTE SENSING, CHIBA UNIVERSITY

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1. Introduction of Chiba University

Chiba University was founded in 1949 and one of the leading academic research centers of Japan. Currently, Chiba University consists of nine faculties, the university library, the university hospital and nineteen research centers including Center for Environmental Remote Sensing (CEReS) [1]. With approximately 11,000 students in the undergraduate program, it has long been one of the largest national universities in Japan. As for the graduate school, annually there are about 2,500 students in master programs and 1,200 students in doctoral programs. The University's four campuses, Nishi-Chiba, Inohana, Matsudo and Kashiwa-no-ha are ideally located in Chiba Prefecture, an area noted for its industrial, intellectual and international achievements. In recent decades, Chiba has undergone rapid development which in many ways rivals the neighboring Tokyo Metropolis. Many national projects have been based in Chiba Prefecture, and now Chiba has one of the main international transport centers (New Tokyo International Airport Narita), one of the largest business centers and resorts (Tokyo Disney land and Tokyo Disney Sea) in Japan. Many new academic and industrial complexes for the advanced sciences (i.e. The Kazusa DNA Research Institute, National Institute of Radiological Sciences) are located in Chiba Prefecture. The developments in Chiba today are representative of tomorrow's Japan.

Chiba University, with the support of the Japanese national government, is extending the frontiers of its international activities. The University is establishing new cooperative relations with numerous overseas universities and developing an even closer relationship with those with which it has already concluded cooperation agreements. The University has already achieved a high degree of participation in international cooperative research projects. Chiba University presently has a large body of international research scholars and students studying on its various campuses. As of 2010, there are 205 sister universities in 39 countries, 293 international research projects in 41 countries and 1068 international students in 51 countries all over the world. Also, Chiba University has 6 International offices in Canada, Finland, Indonesia, Thailand, and China (Beijing and Hangzhou).

2. Center for Environmental Remote Sensing (CEReS)

The Center for Environmental Remote Sensing (CEReS) has contributed to the science community of environmental studies through archiving, processing and disseminating satellite data since its establishment as a national cooperative research center of academic community on remote sensing in April 1995 [2]–[3]. The mission of the CEReS is to conduct research on remote sensing for understanding environmental changes and the interactions between human and the environment. This mission places the CEReS as Japan's leading institution of remote sensing for environmental applications. The CEReS plays an important mission in research and education for remote sensing field in Japan. In education mission, the CEReS already has graduated 159 master students and 98 doctoral students from domestic and overseas since 1995.

The CEReS started the following three programs as a newly, officially accredited center for cooperative use and research cooperation under the Japan government from April 2010: (1) Program 1-Innovation in remote sensing technology and algorithm, (2) Program 2-Integrated use of geoinformation, (3) Program 3-Advanced application of satellite remote sensing.

Program 1-Innovation in remote sensing technology and algorithm (Leader: Prof. Josaphat Tetuko Sri Sumantyo): The limitation of existing approaches has often been recognized

Figure 1. Satellite receiver facilities (NOAA and other satellites) on top of CEReS building.

in the course of the Earth environment studies using remote sensing. In this program, novel sensors and algorithms are explored in order to establish new remote sensing methodologies that enable more in-depth and comprehensive analyzes of various target including vegetation and atmosphere. In this way this program aims at the innovation of remote sensing through such activities as construction and operation of next-generation satellite sensors, and the integration of wide spectral-range observations using optical and microwave remote sensors. The goals of Program 1 is the integration of wide spectral-range observations using optical and microwave remote sensing sensors, and practical applications of innovative remote sensing to global and regional problems. The projects under Program 1 are (1) development of polarimetric synthetic aperture radar onboard ummaned aerial vehicle and microsatellite for microwave remote sensing and their application for Earth observation, (2) Feasibility study of air pollutant and other atmospheric minor gas retrieval from geostationary satellites, (3) Information retrieval from next generation sensors for global environment, especially aimed at the atmospheric and vegetation monitoring, and (4) Implementation of validation and various data applications of the next-generation Earth observing satellite GCOM-C.

Program 2-Integrated use of geoinformation (Leader : Prof. Atsushi Higuchi): This program aims to promote atmospheric terrestrial environmental studies based on integrated use of geoinformation including satellite remote sensing data, ground measurement data, and extracted environmental data. Main research subjects in this program are correction and preprocessing of satellite data, efficient processing methods for a huge volume of satellite data, environmental monitoring method by integrating satellite data and ground data, and extraction of atmospheric / terrestrial environmental parameters. This program has close relationship with the operation of the data distribution and sharing systems of the whole CEReS. The goal of this program is long-term climatology analysis and its implementation by means of the seamless monitoring over more than 20 years, leading to the synergy of land and atmospheric studies and realization of the information center for the Earth environment. The projects under Program 2 are (1) Long-term seamless monitoring of the atmosphere is employed for climatology study, through the high-level analysis of various earth-observing satellites, especially geo-synchronous meteorological satellites, (2) invigorating the atmospheric and land-surface studies through the feedback of the knowledge from the seamless monitoring to the data pre-processing such as calibration and atmospheric correction prior to the land-coverage analysis, (3) the formation of the information center for the earth environment by disseminating the data obtained from this program and other CEReS programs. The international geospatial data sharing system called CEReS Gaia, will promote terrestrial environmental research by integrating existing data and research products through mutual comparison activities.

Figure 2. Prof Josaphat (yellow jacket) with students held ground survey to investigate the circular polarization of microwave characteristics of snow and ice at Saroma Lake, Hokkaido, Japan by using synthetic aperture radar (SAR) and microwave radiometer 18 GHz and 36 GHz.

Program 3-Advanced application of satellite remote sensing (Leader : Prof. Akihiko Kondoh): Since the establishment of the Aerospace Basic Act in 2008, the major purpose of the national policy over the space development and utilization has changed from the stage of research and development to that of wide-range, practical utilization. Thus, it is absolutely needed for the environmental remote sensing community to establish the methodology of utilization of remote sensing for finding, understanding, and solving various problems on both scientific and social bases. In view of such background, this program aims at assigning important problems that must be solved on national and global levels, integrating the results of satellite and ground-based observations, and realizing the advanced application methodology of satellite remote-sensing data through the synergetic activities of scientists representing various fields of environmental monitoring. As the goal of this program, we plan to produce novel application methodology of satellite remote sensing data in combination with the data obtained from ground observations. The targets will include various problems such as desertification, water problem, food security, evaluation of ecological services, urban and rural planning etc. The projects under this program are (1) Monitoring and causal analyzes of environmental changes in Asia, (2) Restorations of sound hydrologic cycle and biodiversity in Chiba prefecture, (3) Study on spatial information system that nurtures the disaster and environmental literacy, and (4) Construction and provision of spatial information helpful to our daily life.

3. Josaphat Microwave Remote Sensing Laboratory (JMRSL)

Josaphat Microwave Remote Sensing Laboratory (JMRSL) in Program 1 of the CEReS promotes research and education in

Figure 3. CP-SAR, GPS-SAR, and GPS-RO sensors onboard Josaphat Laboratory Experimental Unmanned Aerial Vehicle (JX-1).

microwave remote sensing technology and science for future Earth observation, especially development of next generation of synthetic aperture radar (SAR), SAR image signal processing techniques for unmanned aerial vehicle (UAV), aircraft and microsatellite, and SAR image applications [4]. The main projects in JMRSL are (1) Development of circularly polarized synthetic aperture radar (CP-SAR) onboard UAV and microsatellite, (2) Compact CP-SAR for UAV, (3) SAR image signal processing, (4) theory and measurement technique of SAR system, (5) microwave circuits and antennas development for SAR, rocket tracking, GPS-SAR, GPS - radio occultation (RO) sensors, (6) 3 dimensional weather radar and vehicle onboard radar for ice and snow monitoring (see Fig. 2), and (7) long-term consecutive environmental change monitoring by using old maps and satellite images. JMRSL has collaboration with researchers from University of Tokyo, Nihon University, Kyoto University, Osaka University, Japan Aerospace Exploration Agency (JAXA) and some high research dedicated companies, as Weathernews, PASCO, etc., to develop some new technology in remote sensing field. Our laboratory has many study sites in the world for field survey to promote global research and education in microwave remote sensing field. JMRSL already has developed the CP-SAR UAV (see Fig. 3) and microsatellite during the fiscal year 2007 to 2009 under the supporting of Japanese Ministry of Education and Technology (Monbukagakusho), Chiba University Center of Excellent Start-up Program – Microsatellite Institute for Earth Diagnosis, the Japan Society for the Promotion of Science (JSPS); National Institute of Information and Communication Technology (NICT), etc.

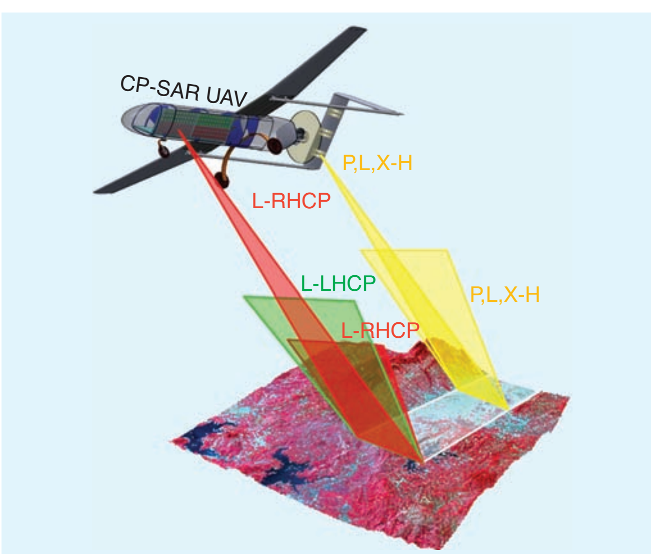

Figure 4. Concept of Circularly Polarized Synthetic Aperture Radar (CP-SAR) and Linear Polarized Synthetic Aperture Radar (LP-SAR) on UAV.

3.1. Circularly Polarized Synthetic Aperture Radar

Synthetic Aperture Radar (SAR) is well-known as a multipurpose sensor that can be operated in all-weather and day-night time. Recently, many missions of SAR sensors are operated in linear polarization (HH, VV and its combination) with high power, sensitive to Faraday rotation effect etc. In this research, we proposed the Circularly Polarized Synthetic Aperture Radar onboard microsatellite (CP-SAR μSAT) that will be launched five years later to retrieve the physical information of Earth surface for Earth diagnosis by using the characteristics of circular and elliptical polarizations. Before the development of microsatellite, we developed UAV for ground experiment of our microwave sensors, including the CP-SAR sensor. Fig. 4 shows the concept of CP-SAR UAV. The CP-SAR sensor is employing the elliptical wave propagation and scattering phenomenon by radiating and receiving the elliptically polarized wave using circular polarized antennas (right- and left-handed circular polarization : RHCP and LHCP), where elliptical polarization includes the special polarization as circular and linear polarizations. UAV is employed for ground experiment (validation and calibration) of CP-SAR before we install this sensor in the microsatellite. The sensor is designed as a low cost, light, low power or safe energy, low profile configuration to transmit and receive LHCP and RHCP, where the transmission and reception are both working in RHCP+LHCP as shown in Fig. 4. Then the circularly polarized waves are employed to generate the axial ratio image

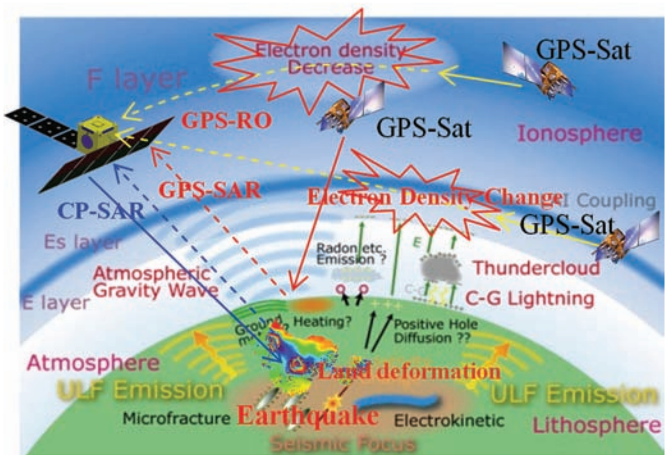

Figure 5. Illustration of CP-SAR μSAT mission.

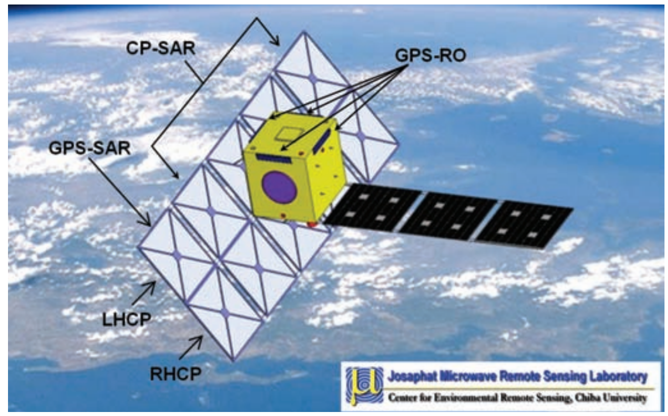

Figure 6. Illustration of microwave sensors (CP-SAR, GPS-SAR and GPS-RO) onboard microsatellite.

(ARI), tilted angle spectrum image, ellipticity ratio image, etc. This sensor is considered not depending to the platform posture, and it is available to avoid the effect of Faraday rotation during the propagation in ionosphere when installed in microsatellite. Therefore, high precision and low noise image is expected to obtain by the CP-SAR.

3.2. CP-SAR Onboard Unmanned Aerial Vehicle (CP-SAR UAV)

In this research, the CP-SAR onboard unmanned aerial vehicle (CP-SAR UAV) as shown in Fig. 3 is developed for CP-SAR ground testing before install it on the microsatellite. The platform called Josaphat Laboratory Experimental Unmanned Aerial Vehicle (JX-1) has 25 kg of payload availability for various microwave sensors (CP-SAR, GPS SAR, and GPS RO) and optic sensors (visible cameras). The UAV operation altitude is 1,000 m to 4,000 m as the optimum altitude for L band CP-SAR sensor.

The specification of CP-SAR sensor for UAV: frequency 1.27 GHz, ground resolution 1m, pulse length 3.9 to 23.87 ms, pulse bandwidth 61.14 to 244.69 MHz, off nadir angle 40^o to 60^o, swath width 1 km, antenna size 1.5 m x 0.4 m for LHCP and RHCP, azimuth beamwidth 6.77^o, range beamwidth 29.78^o, antenna radiation efficiency >80%, PRF 1000 Hz, and peak power 8.65 W (1 km) to 94.38 W (4 km). The CP-SAR has receiver antenna composed by LHCP and RHCP antenna. The data retrieved by LHCP and RHCP antenna is employed to generate the axial ratio, tilted angle, ellipticity ratio, etc. images. These images are used to retrieve the physical information of Earth surface, i.e. soil moisture, biomass, Cryosphere, agriculture, ocean dynamics, land deformation, disaster monitoring, digital elevation model, etc. In this UAV, we also install the linearly or horizontally polarized SAR (LP-SAR) in frequency P-, L-, and X-bands as shown in Fig. 4. The Linearly polarized SAR data will be compared with CP-SAR data, and employ it for some applications.

3.3. CP-SAR mSAT Mission

We employ three microwave sensors in CP-SAR μSAT mission as main sensors, there are CP-SAR, GPS-SAR and GPS-radio occultation (RO), as shown in Figs. 5 and 6. GPS-SAR is an experimental passive SAR sensor. This mission plans to investigate the possibility to receive the GPS pulse and process it to retrieve the SAR image. GPS-RO is an experimental four unit of patch array antenna sensor to receive the GPS signal and process it to retrieve the conditions of electron in the ionosphere to investigate the coupling of total electron charge or density change (GPS-TEC) and land deformation on Earth surface. This coupling is used to predict the earthquake activity with magnitude more than 5, and build the early warning system in Asian countries in the near future. CP-SAR is as active sensor that could transmit and receive the L band chirp pulses for land deformation monitoring, especially for post disaster monitoring.

The main mission of this CP-SAR mSAT is to hold (1) the basic research on elliptically polarized scattering and its imaging technique, and (2) its application development.

In the basic research, we investigate the elliptical (including circular and linear polarizations) scattering wave from the Earth surface, circularly polarized interferometric technique (CP-InSAR), axial ratio image (ARI) generation etc. We hold the analysis and experiment on circularly polarized wave scattering on vegetation, snow, ice, soil, rock, sand, grass etc to investigate the characteristic of elliptical scattering. In experiment of CP-InSAR, we will hold some experiments to compare the InSAR technique by using circular and linear polarizations. This technique will be implemented to extract the tree trunk height, DEM by using the elliptical polarization. The axial ratio image (ARI) will be extracted by using the received RHCP and LHCP wave, then this image is employed to investigate the relationship between the characteristics of ARI and vegetation, soils, snow, ice etc. The image of tilted angle and ellipticity ratio as the response of Earth surface also to be extracted to mapping the physical information of the surface, i.e. geological matters, contour, tree trunk structure and its characteristics, snow-ice classification etc.

In application development, CP-SAR sensor will be implemented for land cover mapping, disaster monitoring, Cryosphere monitoring, oceanographic monitoring etc. Especially, land cover mapping will classify the forest and non-forest area, estimation of tree trunk height, mangrove area monitoring, Arctic and Antarctic environment monitoring etc. In disaster monitoring, CP-SAR sensor will be employed for experiment of CP Differential InSAR in earthquake area, monitoring of volcano activity, forest fire and flood monitoring etc. In snow and ice monitoring, we will employ this sensor to monitor ice berg, glacier, investigation of snow and ice characteristic etc. In oceanographic monitoring, CP-SAR works for monitoring of oil spill, inner wave etc.

As shown in Fig. 7, the CP-SAR μSAT system is composed by attitude control system (ACS), CDS (command and data handling system), EPS (electrical Power Subsystem), and CMS (communication subsystem), where CDS composed by on-board computer (OBC), telemetry and command unit (TCU) and mission data storage unit (MDU). ACS is composed by electromagnetic torque (EMT), GPS receiver (GPSR), sun sensor (SS) and magnetometer (MAG). EPS is composed by battery charge regulator (BCR), power control unit (PCU) and power distribution unit (PDU). Finally, CMS is composed by S-band transmitter (STX), S-band receiver (SRX) and X-band transmitter (XTX).

The specification of the μSAT CP-SAR is altitude 500 to 700 km, inclination angle 97.6 degrees, frequency for CP-SAR 1.27 GHz, polarization TX : RHCP+LHCP and RX : RHCP+LHCP, gain > 30 dBic, axial ratio < 3 dB (main beam), off nadir angle 29 degrees, swath width 50 km, spatial resolution 30 m, peak power 300 W, PRF 2000 – 2500 Hz (duty 6%, average 5.6 W), chirp pulse bandwidth 10 MHz, platform size 1 m $\times$ 1 m $\times$ 1 m, weight 100 kg, and antenna size elevation 2 m and azimuth 5 m. The development of mSAT CP-SAR including design, fabrication and measurements is done in our laboratory. Fig. 8 shows measurement of electromagnetic environment microsatellite in anechoic chamber of JMRSL.

3.4. SAR Image Processing

The Japan Aerospace Exploration Agency (JAXA), formerly known as National Space Development Agency of Japan (NASDA), has operated two Synthetic Aperture

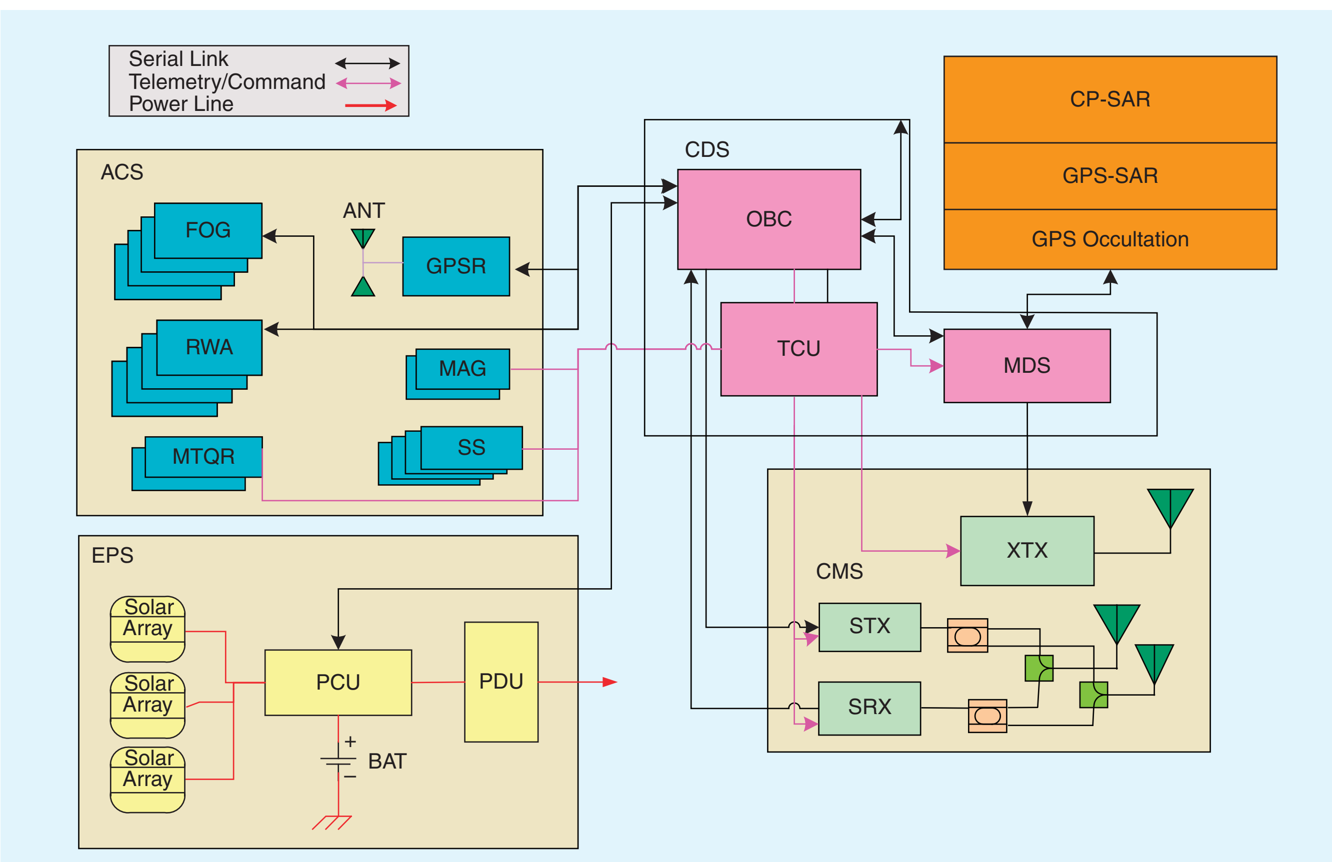

Figure 7. Block diagram of CP-SAR mSAT system.

Radar (SAR) systems on board satellites, namely, the Japanese Earth Resources Satellite Synthetic Aperture Radar (JERS-1 SAR) and the Advanced Land Observation Satellite - Phased Array type L-band Synthetic Aperture Radar (ALOS PALSAR). The JERS-1 SAR operated for a period of six year starting from 15 April 1992 and terminated on 12 October1998 that each image covers a 75 km × 75 km area. Even we develops the original SAR image signal processing for our CP-SAR UAV and CP-SAR mSAT, JMRSL is also developing various methods to analyze the other satellite's SAR images in order to extract physical information such as soil moisture, biomass, and soil type data for Earth surface observation of, for example, land deformation, the cryosphere, agriculture, forestry, volcanic activity etc. A number of methods have been developed to extract land deformation or changes using differential SAR interferometry (DInSAR) to determine the volume change caused by volcanic activity and ground water pumping in urban areas, i.e. Merapi volcano eruption in 2010, land deformation (subsidence) in metropolitan area with field study is Tokyo, Chiba, Jakarta, Kuala Lumpur, Tehran etc. To obtain high-precision volume change of land deformation and its effect to urban management, we also developed long-term consecutive remotely sensed observations by using DInSAR technique to process JERS-1 SAR and ALOS PALSAR images. Fig. 9 shows one of our result to monitor the subsidence cause by over water pumping in Bandung city, Indonesia by using JERS-1 SAR and ALOS PALSAR images.

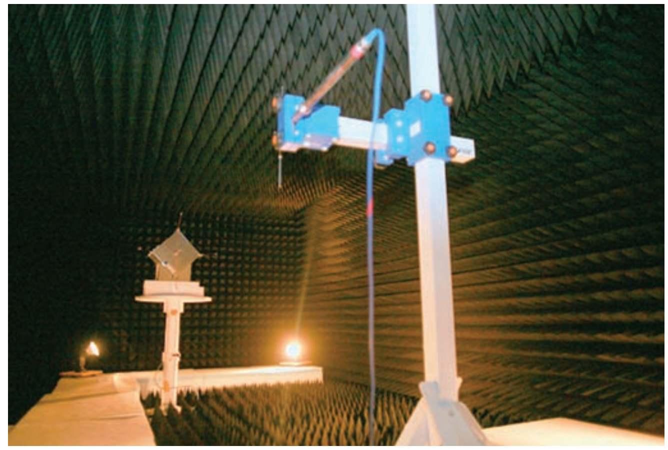

Figure 8. Measurement of electromagnetic environment of microsatellite in anechoic chamber of JMRSL.

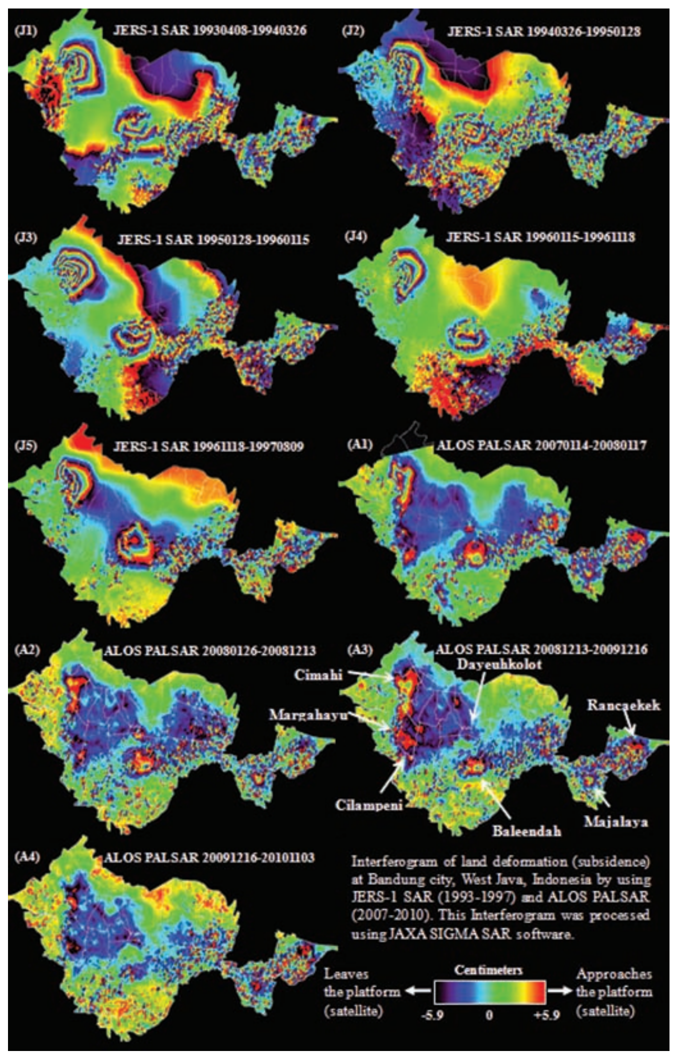

Figure 9. Monitoring of subsidence in Bandung city, Indonesia using DInSAR of JERS-1 and ALOS PALSAR images.

3.5. Old Maps and CEReS Gaia

Started by the hobby of Prof Josaphat to collect the old photogrammetried colonial maps (1884~1945) covering Asian regions published by former Japanese Army, Dutch Army, Thailand Survey Agency, Australian Military HQ, France Army etc, JMRSL have collected thousands sheets of original maps. We try to combine the extracted vector spatial information of old maps (see Fig. 10) with satellite images to analyze one hundred years of Asian environment change spatially. Prof. Josaphat Tetuko Sri Sumantyo and Prof. Ryutaro Tateishi initiated to build the international geospatial data sharing system called "CEReS Gaia" under the project of Ministry of Education and Technology (Monbukagakusho) and the Japan Society for the Promotion of Science – Grant-in-Aid for Scientific Research S (No. 22220011) in FY 2010 to 2014. We build a central international geospatial data sharing server in CEReS and some geospatial servers at overseas collaborated centers. In the future, CEReS Gaia server also will distribute satellite images observed by our microsatellite and images of CP-SAR UAV campaigns. We can analyze the environment change by comparing the geographical information system data of old maps and satellite images.

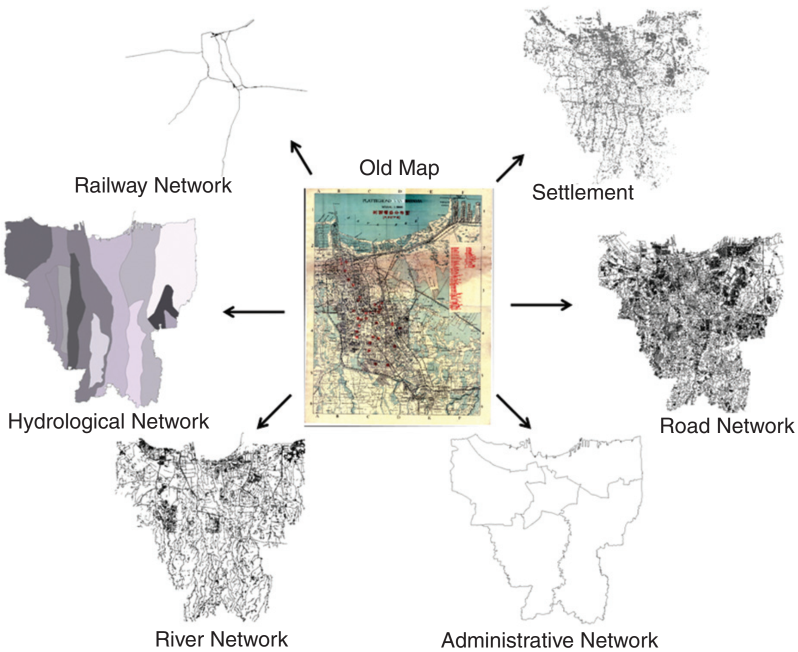

Figure 10. Extraction of spatial information from old map of Batavia city (now Jakarta, Indonesia) (JMRSL collection).

Acknowledgement

The authors thank to the Japan Society for the Promotion of Science (JSPS); the National Institute of Information and Communication Technology (NICT) for International Research Collaboration Research Grant; Chiba University COE Start-up Programme; the Japanese Ministry of Education and Technology (Monbukagakusho); Japan International Cooperation Agency (JICA), Japan Science and Technology Agency (JST), Weathernews, PASCO, Pandhito Panji Foundation etc for supporting Josaphat Microwave Remote Sensing Laboratory.

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(President's Message continued from page 3)

securing an excellent venue, negotiating hotel blocks, and attending to the myriad of details associated with IGARSS. I also thank the GRSS VP of Meetings and Symposia, Adriano Camps, and the GRSS Executive Vice President, Melba Crawford, for their outstanding support during this period.

As a result of a very careful review process, an outstanding technical program has been organized for IGARSS 2011. The theme of the conference is "Beyond the Frontiers: Expanding our Knowledge of the World." This year more than 50 scientists and engineers from around the world worked very hard to finalize the IGARSS technical program during our Technical Program Committee meeting in San Francisco in March. My congratulations and sincere thanks to all the colleagues involved in the review process and session organization for their excellent work during the two-month review and abstract selection process. A special thanks goes to Yoshio Yamaguchi and Ya-Qiu Jin who are doing an outstanding job as co-chairs of the IGARSS Technical Program Committee. The IGARSS 2011 technical program is available online at www.igarss11.org/RegularProgram.asp.

Vancouver is one of the world's most spectacular cities, providing an excellent holiday or vacation destination as well as for the conference. It was named "Top City of the Americas" by Condé Nast Traveler magazine's 2009 Readers' Choice Awards. The area offers travelers both outstanding opportunities for outdoor adventure and the sophisticated amenities of a world-class city. Vancouver was also named a Top 100 World Destination by Trip Advisor's 2008 Traveler's Choice Awards. Just recently (2011), the Economist Intelligence Unit (EIU) named Vancouver the world's "Most Livable City," a title it has been awarded eight times since 2002.

Both the IGARSS 2011 team and I look forward to seeing you in Vancouver in July!

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INDUSTRIAL PROFILE

PLANS FOR THE EVALUATION OF ATMS AND CrIS DATA AT ECMWF

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1. Introduction

The European Centre for Medium Range Weather Forecasts (ECMWF) is one of several Numerical Weather Prediction (NWP) Centers which will be involved in the evaluation of data from the NPP satellite, currently due for launch in October 2011. Data from two sensors: the Advanced Technology Microwave Sounder (ATMS) and the Cross Track Infrared Sounder (CrIS), will supersede existing operational instruments (AMSU-A and HIRS) and become key components of the satellite observing system over the next decade.

In recent years it has been demonstrated that NWP fields can play an important role not only in the passive assessment of satellite data in assimilation systems, but in detecting and actively correcting a range of instrument biases with impressive sensitivity. The high accuracy of the NWP analysis and forecast fields results from the large amount of satellite data ingested in the assimilation system, coupled with a sophisticated forecast model that propagates this observational information forward in time. For temperature sounding channels, for example, instrument biases of several tenths of a Kelvin (in brightness temperature) can be detected easily. The global coverage of NWP models allows instrument performance to be assessed quickly over the full range of measured brightness temperatures and under a diverse set of meteorological conditions, thereby yielding poweful insights into the underlying physical mechanisms causing any biases. In the last ten years NWP has provided valuable information concerning the on-orbit performance of a number of sensors, including AMSU-A, AIRS, IASI, SSMIS[1], TMI[2] and China's FY-3A[3,4,5] sensors. This has been achieved through intensive post-launch evaluation during the early Cal/Val phases, but also through the ongoing and continuous monitoring of data provided by operational NWP centers. NWP complements other aspects of Cal/Val, such as careful pre-launch characterisation, satellite co-locations and aircraft under-flights in developing a comprehensive suite of tools for satellite data validation.

The steady improvement in NWP forecast models (see Figure 1) over the last few decades demands that the on-orbit characterisation of instruments is achieved at progressively higher levels of accuracy . The use of this data in climate science drives a similar, and perhaps even more stringent, requirement for continued improvement.

2. ECMWF

So what is ECMWF ? It's an intergovernmental organisation established in 1975 and is currently supported by more than 30 States. ECMWF is based in Reading, approximately 60 km west of London, where around 220 staff are employed. The annual budget, currently £39M, is funded almost entirely from annual contributions from Member and Co-operating States (see Figure 2). Recent amendments to the ECMWF convention permit additional European States to become members and formally expanded ECMWF's Mission, originally encompassing medium range weather forecasting, to include environmental and climate monitoring.

The current ECMWF global operational forecast model has a horizontal resolution of 16 km, 91 levels in the vertical

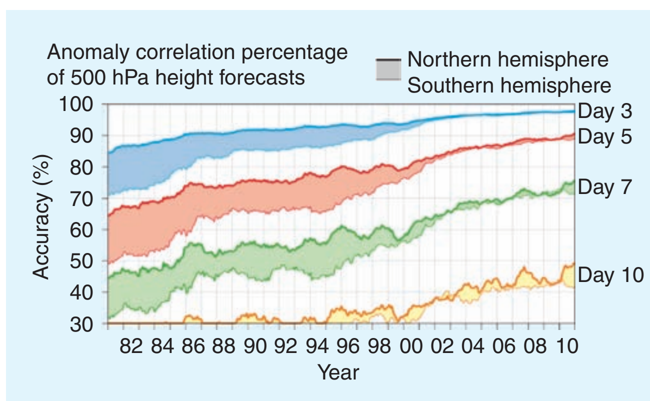

Figure 1. Forecasts improved steadily from 1980 as a result of improvements in the global observing system, more powerful computers, and advances in the science of the ECMWF's data assimilation system and forecast model. Seven-day forecasts in the northern hemisphere became more accurate than the five-day forecasts of 1980, and five-day forecast accuracy reached that of the three-day forecasts made 25 years earlier. In the southern hemisphere, the improvement was even more marked. In the early 1980s, because of the lack of observations, the three- and five-day predictions for the southern hemisphere were not much better than those of the northern hemi sphere for five and seven days respectively. Two decades later, forecasts for both hemispheres were of similar accuracy – a gain of about four days in the accuracy of southern hemisphere predictions, mainly thanks to the use of satellite data. The shaded area shows the differences in forecast accuracy between the hemispheres.

Figure 2. ECMWF Member and Co-operating states

and a model top at 0.01hPa. Forecasts are produced twice daily for forecast ranges up to 15 days. The assimilation and forecasting system is run on an IBM supercomputer with 17,400 processors, which give a sustained performance of ~20 TFlops.

The assimilation system ingests data from more than 50 satellite sensors to produce an analysis, which serves as the initial conditions for each forecast model run. Microwave and infrared sounding data are assimilated directly as radiances and, currently, have the largest positive influence on analysis and forecast accuracies. Data from a constellation of global positioning system radio occulatation satellites, with very low biases, effectively anchor the system in the upper-troposphere to upper stratosphere. The large volume and diversity of satellite data[6], coupled with an efficient 4D-Var assimilation system, results in highly accurate global analysis (and short range forecast) fields of temperature and moisture that can, in turn, be used to identify persistent systematic biases in new satellite instruments.

The satellite section at ECMWF currently employs around 18 scientists involved in the research and development required to maintain and improve the satellite component of the assimilation system. Further support is provided by the Operations Department to archive data streams and to monitor satellite data quality.

3. Case Study: Characterising the FY-3A Microwave Temperature Sounder using the ECMWF model

The ECMWF model was recently used to characterise the performance of China's FY-3A Microwave Temperature Sounder (MWTS). FY-3A is the preparatory platform for a subsequent series of six polar orbiting satellites which will carry increasingly sophisticated payloads[7]. Accurate characterisation of the FY-3A preparatory mission is essential to reduce the risk of sub-optimal performance in subsequent operational missions.

MWTS is a four channel microwave sounder, similar in specification to MSU, an instrument carried on previous NOAA meteorological satellites. The four channels provide information on temperature from the surface to the lower stratosphere. During 2009/10 data from the MWTS was introduced into the ECMWF integrated Forecasting System. These investigations involved the comparison of the data with NWP fields mapped to radiances (using radiative transfer modelling) and showed that the data was affected by two significant biases associated with a shift in the center frequencies of the radiometer passbands and radiometer non-linearities. These biases showed complex geographic variability and had amplitudes of up to 2K[3]. NWP fields were then used to provide better estimates of the pass band centre frequencies and to correct for the non-linearities[4]. The resulting data quality was significantly better than the original data (see Figure 3) and subsequent investigations showed that this improved data quality, in turn, enhanced analysis and forecast accuracies[5].

4. Plans for ATMS and CrIS

Work is currently in progress to adapt the ECMWF IFS to handle ATMS and CrIS data. Proxy data, based on radiative transfer simulations from NCEP forecast fields are currently being archived at ECMWF and preliminary simulations have been carried out at ECMWF. The early availability of proxy data, many months in advance of the launch date, greatly accelerates the development and testing of code to handle the new data and has ensured ECMWF will be able to provide rapid feedback to the Cal/Val team on data quality as soon as real data becomes available. As a recent excellent example of how these arrangements can work, ECMWF was able to provide feedback to EUMETSAT on the performance of instruments just two weeks after the launch of the MetOp-A satellite in 2006.

This early feedback on NPP instruments will include: global fields of model-data differences; estimates of cross-scan biases; assessments of data quality relative to other similar instruments; estimates of on-orbit noise performance as well as information on the temporal evolution of instrument biases.

Detailed plans for the Cal/Val phase were discussed at the NPP Sensor Operational Algorithm Team meeting, held in Greenbelt, MD, on 12–14th April.

5. Conclusion

Together with the other NWP centres involved in the Cal/Val program for NPP (NCEP, NRL and the Met Office) ECMWF hope to make a significant contribution to the NPP Cal/Val effort by providing rapid feedback on data quality during the early orbit commisioning phase as well as the subsequent pre-operational phases. Recent experience with other satellite sensors has shown that NWP can detect a range of biases with very high sensitivity. The high accuracy and global coverage of NWP fields enables very efficient

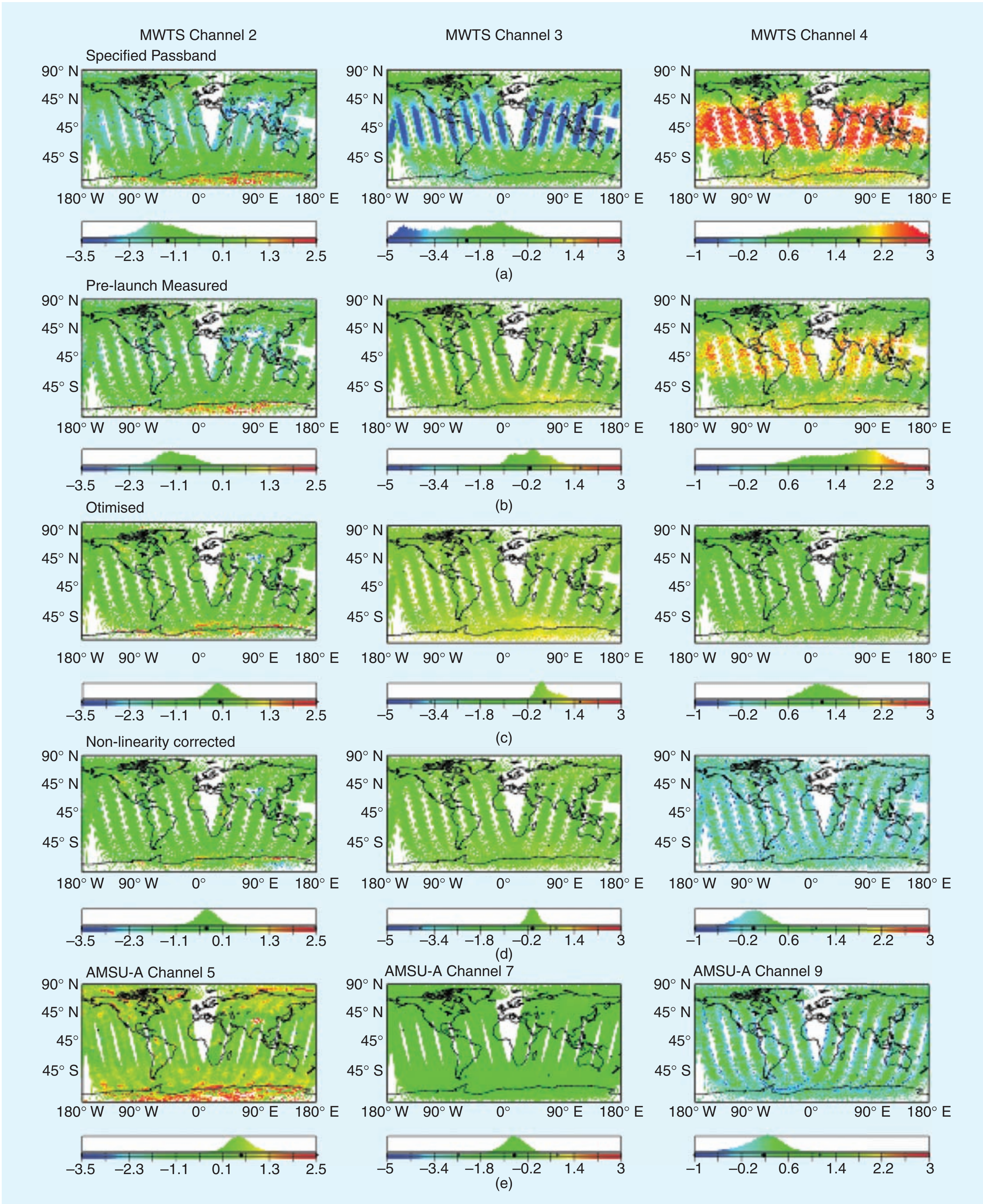

Figure 3. Maps of data-model brightness temperature differences, also known as first guess departures, in Kelvin, for (left to right columns) MWTS channels 2-4 showing departures using (a) design specified passbands; (b) the pre-launch measured passbands;(c) the optimised passbands based on offline estimates of the new passbands; (d) after non-linearity correction and (e) the equivalent MetOp-A first guess departure maps. The spots at the base of the histograms indicate the mean first guess departure. MWTS Channels 2,3 and 4 are nominally centred at 53.596, 54.94 and 57.29 GHz. The model fields used here are short range forecast fields.

identification of many of the underlying physical mechanisms causing instrument biases, facilitating the development of optimal corrections.

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[6] Radnoti G, Bauer P, McNally A, Cardinali C, Healy S, de Rosnay P, 2010. ECMWF study on the impact of future developments of the space-based observing system on Numerical Weather Prediction, ECMWF Technical Memorandum Number 638. (http://www.ecmwf.int/publications/library/do/references/show?id=89944)
[7] Dong, C., et al., 2009. An Overview of Chinese New Weather Satellite FY-3A. Bulletin of The American Meteorological Society, 90, 1531–1544.

(Editor's Comments continued from page 4)

this issue. There are many engineers and scientists among our Society Members who meet the eligibility criteria but are not yet Senior Members. Once again I encourage them all to apply and all IEEE Senior Members of GRSS to nominate eligible colleagues for this valuable recognition.

As a final remark, 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.

I wish you a relaxing yet productive summer, and I am looking forward to meeting most of you at IGARSS 2011 in Vancouver.

Lorenzo Bruzzone
Editor, IEEE GRSS Newsletter

Call for Papers

IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (J-STARS)

Special issue of *Interoperability architectures and arrangements for multi-disciplinary Earth Observation systems and applications*

Papers are solicited for a Special Issue of IEEE J-STARS on *Interoperability architectures and arrangements for multi-disciplinary Earth Observation systems and applications.*

Understanding and managing the Earth environment requires multi-disciplinary capabilities – often at a global scale - and the formation and operation of distributed, multidisciplinary collaborative teams. This is a Science & Technology as well as a cultural challenge. To meet this need there have recently been a number of interoperability initiatives and programs that focus on improving access to, and usability of remote sensing and other Earth Observation resources for policy making and decision support.

In a large-scale integrated system, System of Systems (SoS) components can operate independently to offer products or services satisfying the requirements of various customers. An holistic technology architecture within a complex “ecosystem” (like the Earth Observation domain) is comprised of heterogeneous data models, services, and applications that mix multi-disciplinary capabilities and resources. These capabilities are either managed at the enterprise level by big organizations (e.g. WMO, UN, EPA, EEA, EC DG Env) or at the individual level by scientists (e.g. Facebook, iPhones, individual blogs, Wiki sites). A successful architecture must take a comprehensive and inclusive approach to all of these resources and tools. Such a global scale system of systems approach is essential to study and address global challenges, including: poverty reduction, food security and agricultural production, integrated water resource management, natural resource management (especially forests and biodiversity), migration, urbanization, land degradation, climate change, and safe and reliable energy supply.

The papers considered for this special issue will address recent breakthroughs in the science and technology useful for implementing multi-disciplinary interoperability. They will include the introduction and discussion of new or advanced multi-disciplinary interoperability solutions (e.g. multi-disciplinary data models, vocabularies, discovery & access service protocols, encoding languages, etc.), as well as the description of innovative multi-disciplinary systems and applications (e.g. Earth System Science applications or multi-disciplinary Observatory Systems). Papers are being solicited in (but not limited to) the following areas:

Comprehensive and inclusive solutions for multi-disciplinary Earth Observation capabilities, addressing:

- The SoS approach for Earth Observation resources cooperation;
- Multi-disciplinary Interoperability Arrangements for Earth Observation resource (data and services) discovery, access, processing, and use; the service-oriented science;
- Multi-disciplinary interoperability Arrangements for cooperation between environmental models, model-based systems, and Earth Observation sensors;
- The GEOSS “Model Web” approach.

The benefits and outcomes of holistic approaches and multi-disciplinary advances for important Societal Benefit Areas, including:

- Climate, Biodiversity and Ecosystems; Water, Drought, and Agriculture; Health; Weather; Disasters.

Multi-disciplinary initiatives or pilots developing operational frameworks by applying interoperability arrangements and SoS solutions for Earth Observation resources.

- GEOSS Common Infrastructure (GCI) and Architecture Implementation Pilots (AIP), WMO Information Systems (WIS), National and International Spatial Data Infrastructure initiatives e.g. INSPIRE, the Global Monitoring for Environment and Security (GMES) initiative, CEOS infrastructure

Manuscript submission deadline: October 1, 2011

Inquiries concerning the Special Issue should be directed to the Guest Editors. Papers in electronic format can be submitted using the manuscript central web link http://mc.manuscriptcentral.com/jstars.

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IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing

CALL FOR PAPERS
UPCOMING SPECIAL ISSUE – HUMAN SETTLEMENT MONITORING USING MULTIPLE EO DATA

Guest Editors: Paolo Gamba, Uwe Stilla, Carsten Juergens, Derya Maktav

Submission deadline: October 31, 2011

This special issue, which is scheduled for publication in the last quarter of 2012, follows the very successful series of the Joint Urban Remote Sensing Events (JURSE), held every two years since 2005. The possibility to jointly use optical and radar VHR data, as well as future hyperspectral sensors from airborne and spaceborne platforms, at the global level, open the path for more researches oriented to the analysis of these data for urban monitoring at different geographical scales. Additionally, there are new methodologies for VHR SAR data interpretation that exploit fundamental characteristics of the radar signal to improve the 3D representation of the urban landscape at a level never reached before. The use of LIDAR data has become widespread and applications exploiting laser scanning for change detection in urban areas have been exploited in recent disasters, such as the Haiti earthquake.

Papers are solicited on land cover/land use mapping using SAR and/or optical VHR data in urban areas, monitoring land use/cover and environmental changes in urban areas, change detection/feature extraction/data fusion for urban scene interpretation, human settlement monitoring and change modeling using remotely sensed data. Submissions are encouraged however in a broad range of algorithms which demonstrate substantive use of remote sensing sensors and techniques for human settlement mapping, monitoring and analyzing.

The IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (J-STARS) is a quarterly publication of the Geoscience and Remote Sensing Society and the IEEE Committee on Earth Observations. Papers should address current issues and techniques in applied remote and in situ sensing, their integration, and applied modelling and information creation for understanding the Earth. Applications are for the Earth, oceans and atmosphere. Topics can include observations, derived information such as forecast data, simulated information, data assimilation and Earth information techniques to address science and engineering issues of the Earth system.

Procedure:
Prospective authors should submit their manuscripts electronically using the following web page: **http://mc.manuscriptcentral.com/jstars**. Instructions for creating new user accounts, if necessary, are available on the login screen. Please indicate in your submission that the paper is intended for the Human Settlements Special Issue by selecting "Human Settlements J-STAR Special Issue" from the menu for manuscript type.

Inquiries concerning the Special Issue should be directed to the Lead Guest Editor:

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Phone: +39-0382-985781, Fax: +39-0382-422583
Email: paolo.gamba@unipv.it

JSTARS Special Issue on Pattern Recognition in Remote Sensing

Submission Deadline: October 31, 2011

A Special Issue of the *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS)* in the combined fields of **Pattern Recognition and Remote Sensing** will accept full journal papers up to October 31, 2011. This Special Issue is associated with the 6th IAPR Workshop on Pattern Recognition in Remote Sensing (PRRS 2010) that took place on August 2010 in Istanbul, Turkey as part of the International Conference on Pattern Recognition (ICPR 2010). Both PRRS and ICPR are sponsored by the International Association for Pattern Recognition (IAPR). PRRS 2010 is also sponsored by the IEEE Geoscience and Remote Sensing Society. PRRS workshops are implemented by the IAPR Technical Committee 7 on Remote Sensing.

The PRRS Workshop has established itself as an important event for scientists involved in the combined fields of pattern recognition and remote sensing. These two research fields have always overlapped, but the large volumes of remote sensing data now coming from the last generation sensors require new advanced algorithms and techniques for automatic analysis. The workshop provides an ideal means to spread and exchange experiences by international researchers. However, to further advance this interdisciplinary science, a Special Issue on Pattern Recognition in Remote Sensing will be supported by JSTARS. The papers will encompass research that is interdisciplinary in the sense of applying novel pattern recognition techniques to unsolved problems in remote sensing image detection and analysis.

The objective of the Special Issue, **open to all researchers**, is to select outstanding contributions on recent advances in the combined fields of pattern recognition and remote sensing. The issue will be focused on the use of pattern recognition methods in the analysis of data collected from satellites or airborne sensors used for Earth observation. The special issue will include high quality papers presented at the workshop as well as other papers on the considered topic that are directly submitted to the special issue. All papers will undergo a peer review process in accordance with the requirements of the journal. Contributions are encouraged from professionals in research, industrial, and academic environments.

Prospective authors should follow the regular guidelines of *JSTARS*, and should submit their manuscripts electronically to ***http://mc.manuscriptcentral.com/grs***. Please indicate during your submission that the paper is intended for this Special Issue.

Inquiries with respect to the special issue should be directed to the Guest Editors:

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CALL FOR PAPERS

IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing

Special Issue on

Optical Multi-Angular Data

Papers are solicited for a Special Issue of IEEE J-STARS on optical multi-angular data.

In the past few years, it has been shown how angular measurements can be exploited to provide not only improved accuracies relative to single-angle approaches, but also unique information about the surface considered. As a consequence, several satellite missions were designed to acquire imagery at different viewing angles, such as CHRIS/PROBA, MISR/TERRA, POLDER/ADEOS, and more recently, WorldView-2. Compared to traditional single-shot remote sensing, multi-angle acquisitions allow the observation of the same object at various directions, providing valuable information on the characteristic bidirectional reflectance and 3D structural information of the target.

The papers considered for this special issue will address recent breakthroughs in science and technology, and all aspects related to remote sensing multi-angular applications. Papers are being solicited in (but not limited to) the following areas:

- bidirectional reflectance distribution function
- 3D building reconstruction
- extraction of digital elevation map
- atmospheric parameter estimation
- land-cover/land-use classification improvement
- pan-sharpening
- image super-resolution
- vehicle velocity estimation
- other topics related to the use of multi-angular acquisitions

Manuscript submission deadline: July 31, 2011
Publication of the Special Issue: February 2012

Inquiries concerning the Special Issue should be directed to the Guest Editors. Papers in electronic format can be submitted using the manuscript central web link http://mc.manuscriptcentral.com/jstars Instructions for authors are available at this site.

Guest Editors

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Dr. Qian Du, Department of Electrical and Computer Engineering, Mississippi State University, USA,
Tel: 1-662-325-2035, E-mail: du@ece.msstate.edu

Aalto University is a new university with over a century of experience. Created from a high-profile merger between three leading universities in Finland – the Helsinki School of Economics, the Helsinki University of Technology and the University of Art and Design Helsinki – Aalto University opens up new possibilities for strong multi-disciplinary education and research. The university's ambitious goal is to rank among the top universities in the world in its areas of specialization. At Aalto there are 20,000 students with around 75,000 alumni. We have a staff of 4,500 including 300 professors.

Aalto University School of Electrical Engineering invites applications for

TWO TENURE TRACK POSITIONS IN RADIO SCIENCE AND ENGINEERING

The positions are located in the Department of Radio Science and Engineering (RAD). RAD is a recognized center of excellence both in education and in research. Research and teaching in RAD focuses on understanding of the physics of electromagnetic waves (from radio to terahertz frequencies and beyond) and applying this knowledge for the benefit of the society. RAD consists of research groups in radio engineering, electromagnetics, circuit theory, and space technology (especially remote sensing). Research and teaching in RAD is introduced in more detail in the separate document "Department of Radio Science and Engineering", see http://radio.tkk.fi/en/tenure.

The tenure track is open to talented individuals who have excellent potential for a scientific career within the broad area of Radio Science and Engineering. On the basis of their experience and competence, applicants will be placed on any of the four levels of the tenure track system: Assistant Professor (1), Assistant Professor (2), Associate Professor, or Full Professor. The candidates for the two first-mentioned levels are appointed for a fixed term, while the candidates for Associate Professor positions are appointed either permanently or for a fixed term. Full Professor positions are permanent positions. Throughout their careers, those under the academic tenure track system are expected to exercise and guide scientific research, to provide related higher academic education, to follow the advances of their field, to participate in service to the Aalto University community, and to take part in societal interaction and international collaboration in their field. Individuals placed on the Aalto University tenure track for professors have the possibility to advance in their career through regular performance assessments.

For details on submitting the application and on the requested documents, please see the application instructions on http://www.aalto.fi/en/openpositions. The applications for the tenure track positions are to be submitted no later than on the **12th August 2011**.

Aalto University reserves the right for justified reasons to leave the position open, to extend the application period, and to consider candidates who have not submitted applications during the application period.

For additional information

please contact Head of Department,
Professor Antti Räisänen, tel. +358 9 470 22241,
or
HR Coordinator Jaana Hänninen, tel. +358 50 532 1732.
E-mail addresses: firstname.lastname@aalto.fi (substitute a for ä).

2011 IEEE International Geoscience and Remote Sensing Symposium

VANCOUVER 仙台 2011

IGARSS

July 24-29, 2011, Vancouver, Canada

Beyond the Frontiers: Expanding our Knowledge of the World

Welcome!

Because of the March earthquake and tsunami disaster in Japan, the Geoscience and Remote Sensing Society (GRSS) and the IGARSS 2011 team jointly decided to move IGARSS 2011 to Vancouver, Canada.

Please join us at the Vancouver Convention Center July 25 - July 29 for IGARSS 2011. Check our website (www.igarss11.org) for up-to-date information on the technical program, the venue, hotels, and the social program.

We look forward to welcoming you in Vancouver!

Jon Atli Benediktsson
President, IEEE GRSS

Motoyuki Sato
General Chair, IGARSS 2011

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Capilano Suspension Bridge
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Vancouver

IPIN'2011

INTERNATIONAL CONFERENCE ON
INDOOR POSITIONING AND INDOOR NAVIGATION

COLLABORATIVE POSITIONING AND NAVIGATION

http://ipin2011.dsi.uminho.pt

SEPTEMBER 21-23, 2011, GUIMARÃES, PORTUGAL

SHORT PAPER SUBMISSION DEADLINE: 30.MARCH.2011

Universidade do Minho
Escola de Engenharia

IEEE PORTUGAL SECTION

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

Earthzine Launches Extreme Weather Theme, Earthly Updates Feature

Jeff Kart

Earthzine Managing Editor

Earthzine.org is launching new content with the recent addition of two staffers, Managing Editor Jeff Kart and Science Editor Lisa Rudy.

That content includes an Extreme Weather Theme which began in March and runs through June (earthzine.org/extreme-weather/). Guest Editor for the theme is Dr. J. Marshall Shepherd, with the University of Georgia's Department of Geography.

Earthzine.org also recently ran its first in a weekly series called Earthly Updates, focusing on International Earth Day 2011 (earthzine.org/2011/04/22/international-earth-day-2011/).

We plan to provide similar Earthly Updates on an ongoing basis, highlighting interesting and timely Earth Observation-related events and resources.

If you haven't already, please "like" us on Facebook (facebook.com/Earthzine) and/or follow us on Twitter (twitter.com/earthzine), to keep up with what we publish. We also share links and other Earth Observation-related items here.

To sign up for our newsletter, sent out on the full moon, see the link on our front page, or go to earthzine.org/subscribe-to-our-newsletter/).

The 3rd International Conference

Microwaves, Radar and Remote Sensing Symposium

25-27 August 2011,
Kiev, Ukraine

MRRS 2011

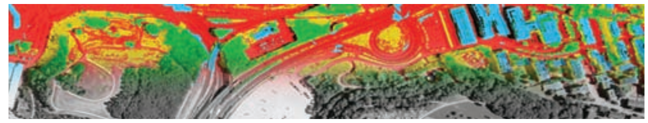
http://ieee.nau.edu.ua/index-22.html

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)



IEEE/ISPRS workshop

Computer Vision for Remote Sensing of the Environment

November 7, 2011
(in conjunction with ICCV 2011, Barcelona, Spain)

Aims and Scope
The workshop aims to bring together researchers to discuss contributions of computer vision to the analysis of remote sensing imagery. The event is organized jointly between IEEE CS, IEEE GRSS and ISPRS Commission 3.

Paper Submission: *July 8, 2011*
Submitted manuscripts shall be full papers (8 pages IEEE style, see webpage) and will undergo double-blind review. The proceedings will be published by IEEE.

Organizers
Konrad Schindler, *ETH Zürich*
Wolfgang Förstner, *Bonn University*
Nicholas Paparoditis, *Institut Géographique National*

Further Information
http://recherche.ign.fr/isprs/CVRS/

UPCOMING CONFERENCES

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

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

Name: GI Forum 2011
Dates: July 5–8, 2011
Location: University of Salzburg
E-mail: office@gi-forum.org
URL: http: //www.gi-forum.org

Name: 6th International Workshop on the Analysis of Multi-Temporal Remote Sensing Images (Multitemp2011)
Dates: July 12–14, 2011
Location: Trento, Italy
Contact: Prof. Lorenzo Bruzzone
E-mail: multitemp2011@disi.unitn.it
URL: http: //www.multitemp2011.org/

Name: 2011 IEEE Geoscience and Remote Sensing Symposium(IG ARSS2011)
Dates: July 24–29, 2011
Location: Vancouver, Canada
URL: http: //www.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: http: //www.isidf2011.casm.ac.cn

Name: Workshop on Pattern Recognition in Remote Sensing
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 52)

The Institute of Electrical and Electronic Engineers, Inc.
445 Hoes Lane, Piscataway, NJ 08854

(UPCOMING CONFERENCES continued from page 51)

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: http: //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